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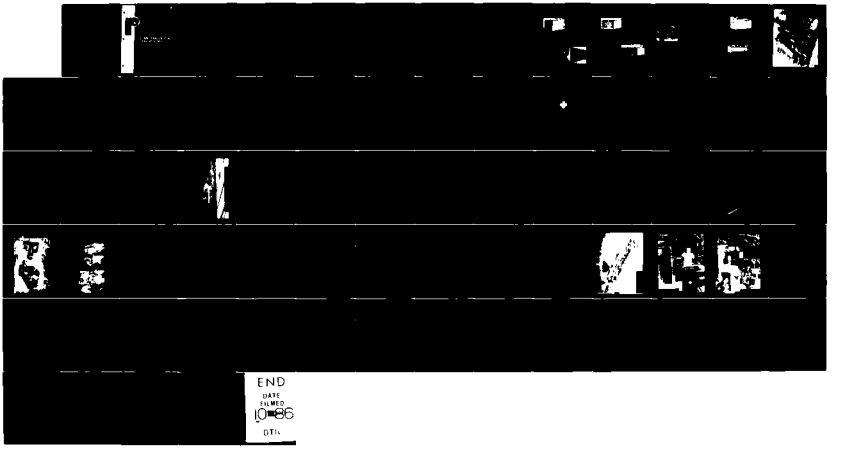

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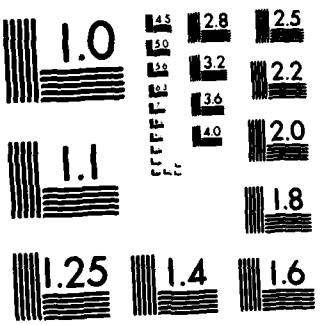

DEFENSE STANDARDIZATION
AND SPECIFICATION PROGRAM

STANDARDIZATION CASE STUDIES

17 MARCH 1986

FOREWORD

This pamphlet, developed for the ~~Defense Materiel Specifications and Standards Office (DMSSO)~~ DSPO, provides instructors with selected standardization case studies. One way to present the studies is to provide only the first part to a student work group (1-6 students per work group). After some period of time for the group to develop a course of action for the case and to address the discussion topics, the group should present its "solution." The second part or the "outcome" should then be distributed, and time allowed for group review and further discussion.

The students should be permitted to retain a complete set of case studies as printed for further use as appropriate. The pamphlet also contains appendices which should be useful in the identification of cost benefits and the preparation of additional case studies.

Although the pamphlet was primarily developed for use in the Defense Specification Management Course, conducted by the U.S. Army Logistics Management Center, Fort Lee, Virginia, instructors for other training courses for senior level acquisition and program managers should consider using it as a part of their curriculum. Copies of any additional standardization case studies developed by users of this pamphlet would be appreciated, and should be sent to ~~DMSSO~~ DSPO.

For additional information on the case studies and standardization training in general, contact the Office of the Assistant Secretary of Defense (Acquisition and Logistics), DSPO, 5203 Leesburg Pike, Suite 1403, Falls Church, VA 22041-3466, area code (703)756-2340, or AUTOVON 289-2340.

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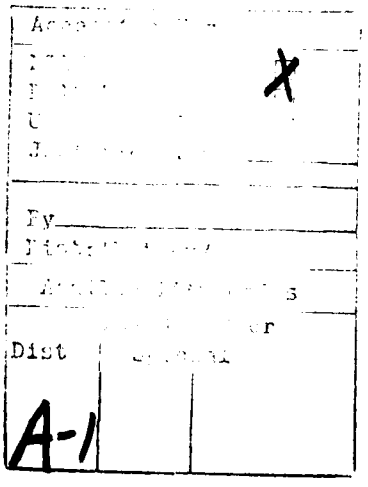

RE: NATO/Unclassified, Page III-5
This is a sample page per Mr. Lee Rogers, DSPO

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IDENTIFICATION OF SERVICE WIDE PROBLEMS WITH TACTICAL SHELTERS RESULTS IN SIGNIFICANT COST SAVINGS THROUGH STANDARDIZATION

Purpose

This case study focuses on the DOD Family of Standard Tactical Rigid Walled Shelters and the dollar savings and cost avoidance that have been achieved as a direct result of standardization action within the DOD.

Background

The sophisticated, complex equipments used by the Armed Services and the specialists who operate them require appropriate protection in rugged environments. Shelters must be highly mobile, environmentally controlled, and provide work-in/live-in space. In addition to tactical command and control applications, transportable structures are needed for field hospital surgical suites, pharmacies, food preparation facilities, maintenance shops, communications centers, and other support activities. Traditionally, the Services have used tents and rigid-walled shelters specially designed for each new system.

Problems

With the advent of early rigid walled shelters and lack of standardization parameters, commanders were faced with more than 100 different special purpose shelters in their inventories. This myriad of shelters evolved simultaneously with the development of specialized field activities and were produced in limited numbers at relatively high costs. Due to little interchangeability of specialty parts, maintenance and field support were often inadequate. The shelters were often incompatible with commercial modes of transportation including container ship transport requirements.

Each service was independently investing manpower and monetary resources into their shelter programs which resulted in many duplicative efforts. When a Service identified a shelter requirement, and needed to prepare a specification document, the cognizant technical office would contact the activity responsible for Federal Supply Class 5410--Prefabricated and Portable Buildings, or the assignee activity for the end item or material being sheltered. With no single assignee activity monitoring the development and control of shelter specifications, the system was circumvented to satisfy individual service needs, resulting in proliferation of many shelter configurations or designs.

Discussion Topics

1. What are the economic disadvantages to the methodology as it existed?

2. Describe a possible course of action which could help prevent duplication of research and development efforts by the Services and reduce the variety of shelters being purchased and supported?

Outcome

Initial efforts toward standardization of shelters began with the intent of reducing the different varieties of shelters and the total quantities in inventories. In 1974, the Deputy Secretary of Defense directed that an ad hoc committee conduct a service-wide review of shelter development activities. The committee recommended that a Joint Committee on Tactical Shelters (JOCOTAS) be established and that the Army be designated as the lead service for execution of a DOD Tactical Shelter Program. A new Federal Supply Class (FSC 5411 - Rigid Walled Shelters) was created with Natick Research and Development Center designated as both the Executive Secretary of JOCOTAS and the standardization assignee activity for the new class.

A formal JOCOTAS charter was developed and, after a thorough analysis, the service representatives determined that a standard family of 13 tactical shelter types would meet DOD needs. With JOCOTAS coordination, the proliferation of special purpose shelters could be eliminated and duplication of research and development efforts by the Services substantially curtailed.

To economically accomplish the world-wide mission of the Services, the JOCOTAS adhered to the international standards that had been established for cargo containers. Intermodal transportation had significantly improved with the advent of standard cargo containers. JOCOTAS endorsed DOD Instruction 4500.37 which supported the standard container concept and the committee directed that future shelter developments conform to International Organization for Standardization (ISO) dimensional and structural requirements for containers. Currently 10 of the 13 shelter models conform to the ISO standards. The dimensions, corner fitting specifications, and structural requirements set by ISO facilitate shelter handling at domestic and foreign locations as the shelters are compatible with commercial container ships, truck, rail, and air modes of transport. While the ISO standards use metric dimensions, these are "soft conversions" of the internationally recognized container modules which were originally defined in inch-pound units.

MIL-STD-907A, promulgated in 1982, establishes specific design criteria for effective, reliable shelters. Shelters produced using these standards are operable in various environments, capable of all transport modes, and usable by all of the Services.

The DOD Standard family of shelters consists of four classes:

Class one, non-expandable - which are used in the same size and shape in which they are transported. (Exhibit 1).

Class two, expandable - which are expanded from the transport size to a larger size at extension ratios of three to one or less. (Exhibit 2).

Class three, highly expandable - which have expansion ratios greater than three to one from their transport size. (Exhibit 3).

Class four, knockdown - which are reduced in height and nested with identical items for transportation. (Exhibit 4).

In most types, the shelters double as containers for their internal systems or equipment during transportation. Some of the functional system configurations possible using the four classes of shelters include:

- field hospitals (Exhibit 5) and dental facilities
- supply depots and maintenance support
- feeding systems
- administrative/living quarters
- communications centers

Payoffs

Prior to standardization, several hundred nonstandard shelters were required to meet the needs of the services. Standardization reduced this to 13. During 1984-85, the Services spent approximately $192 million to procure 6,104 standard shelters. Standard shelters can be expanded from the basic 8 X 8 X 20 feet to 8 X 50 X 20 feet, depending upon the Class as described above. The average unit cost of the 1984-85 buy was $32,000. In 1972, prior to this standardization effort, the average unit price for the most common size, 7 1/2 X 7 1/2 X 13 feet, was $40,000. In 1985 dollars that is equivalent to $104,000. It is clearly evident that based on a planned shelter procurement of $600 million during the period 1984-88, the Services will be getting considerably more value than in the past.

Standardization has significantly reduced logistics support costs associated with the procurement and inventory levels of spare parts for shelters. Previously an average of ten specialized shelters were developed each year in addition to modification of existing designs. Engineering development, fabrication of a prototype, testing, preparation of production documentation, manuals for maintenance, and logistics cost a minimum of $1 million for each specialized design. While a few shelters with specialized characteristics are still required, the Services' tactical shelter standardization program obviates the development of a least seven new shelters each year. In addition to the cost avoidance of $7 million each year, additional economies accrue from larger production runs. While these economies cannot be calculated exactly, an indication of the magnitude of the cost avoidance is given by the actual costs for a nonstandard shelter of approximately 8 X 8 X 15 feet. One of the largest manufacturers provided 225 of these for $25,000 each. Another order for just five shelters cost $110,000 each. In another example, when the production run exceeded 200 units, a particular shelter cost the procuring agency $50,000. In quantities of two or three, these same shelters cost $130,000 each.

Standardization of tactical shelters has resulted in more manufacturers responding to solicitations. Lower quotations have resulted not only from this competitive environment but from improved productivity methods and increased investment in research and development by industry. They are now motivated to install fixtures and tooling to produce standard shelters knowing that their investments will be amortized over longer production runs. This tooling is also "harder" in that the ISO module defines dimensions. Specialized designs do not usually benefit from "hard tooling"that results in a more uniform product, better quality and higher production rates. Enhanced competition and productivity are most evident in the average unit cost for standard shelters.

Shelter standardization has focused attention on the significant size of DOD's requirement for shelters. It has brought together the user and supplier community

to solve long term technical problems, and improve quality and productivity. As an example, ASTM Subcommittee E-6.53 has been organized to develop product specifications and test methods to improve the durability of composite panels used in tactical shelters. The major shelter manufacturers, the Services, and material suppliers are working together to the mutual benefit of all parties. This subcommittee is chaired by a specialist from the National Bureau of Standards.

Other benefits include improved maintainability through the interchangeability of parts for like units, configuration flexibility, add-on capability, and quicker erection times. In addition, the shelters can be reconfigured and deployed for other applications resulting in lower long term deployment costs and significant cost avoidance by eliminating dollars spent on permanent construction that would be later abandoned.

Maximum standardization has been achieved with this program while enhancing mobility and deployment capabilities of U. S. forces.

Current Status

To create an efficient acquisition and logistics process to support the new family of shelters, a Joint Logistics Commander's (JLC) panel has been formed. It has initiated such tasks as:

- Joint technical manuals for each type of shelter
- Depot interserviceability capability
- Reliability/Availability/Maintainability data collection system for use by all the Services
- Ensuring the compatibility of ancillary equipment such as jacks, dolly sets, environmental control units, and power distribution units with the standard shelters
- Providing shelters to systems developers as government furnished equipment (GFE)
- Drafting a joint services regulation on acquisition and logistics policy for shelters which was subsequently accepted by the JLC for promulgation in December 1983

The Army is developing a similar standardization program with the TEMPER tentage system. Like the shelters, the TEMPER tents are modular in design and can be configured to suit a variety of user needs.

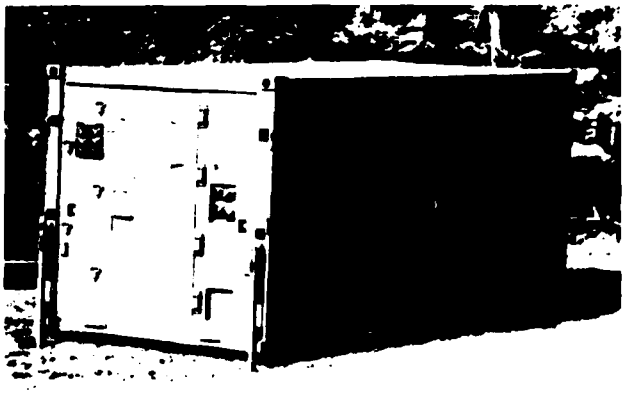
Topics For Further Discussion

1. How could commercial requirements for transport anywhere in the world be accommodated?
2. List the considerations for an efficient acquisition process involving all of the Services.

NON-EXPANDABLE SHELTERS

(Class 1)

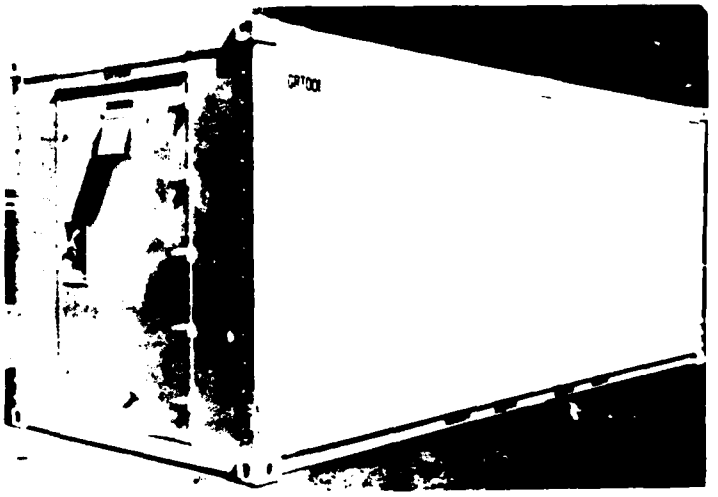
8x8x20 ISO



GENERAL PURPOSE

- 8'Hx8'Wx19'11"L EXTERIOR DIMENSIONS
- 7'1"Hx7'7"Wx19'1"L INTERIOR DIMENSIONS
- 3900 LB TARE WEIGHT
- 10,000 LB PAYLOAD
- 13,900 LB GROSS WEIGHT

8x8x20 ISO



- 8'Hx8'Wx19'11"L EXTERIOR DIM.
- 7'1"Hx7'6"Wx19'4"L INTERIOR DIM.
- 4900 LB TARE WEIGHT
- 15,100 LB PAYLOAD
- 20,000 LB GROSS WEIGHT
- SPECIFICATION MIL-M-81957A(AS)

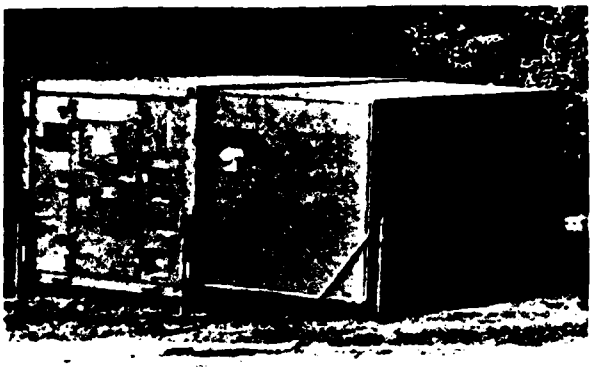
BASIC MOBILE FACILITY

(Exhibit 1)

EXPANDABLE SHELTERS

(Class 2)

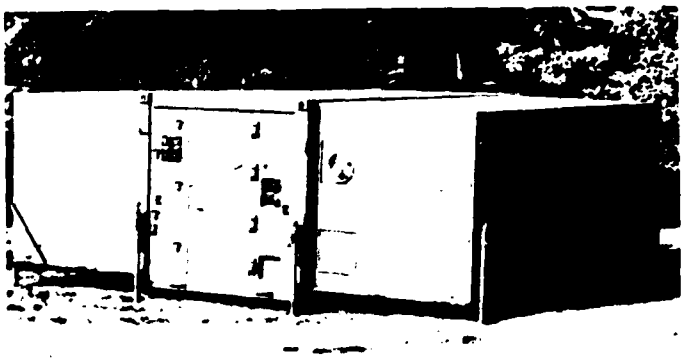
8x8x20 ISO



ONE SIDE EXPANDABLE

- 15,000 LB GROSS WEIGHT
- 25 MINUTES, 4 MEN ERECTION TIME
- 8'Hx8'Wx19'11" EXTERIOR DIMENSION
- 7'1"Hx6'5"Wx19'1"L INTERIOR NON-EXPANDED
- 7'1"Hx14'6"Wx18'4"L INTERIOR EXPANDED
- 5200 LB TARE WEIGHT
- 9800 LB PAYLOAD

8x8x20 ISO



- 8'Hx8'Wx19'11"L EXTERIOR DIMENSION
- 7'1"Hx6'Wx19'1"L INTERIOR NON-EXPANDED
- 7'1"Hx21'6"Wx18'4"L INTERIOR EXPANDED
- 6900 LB TARE WEIGHT
- 8100 LB PAYLOAD

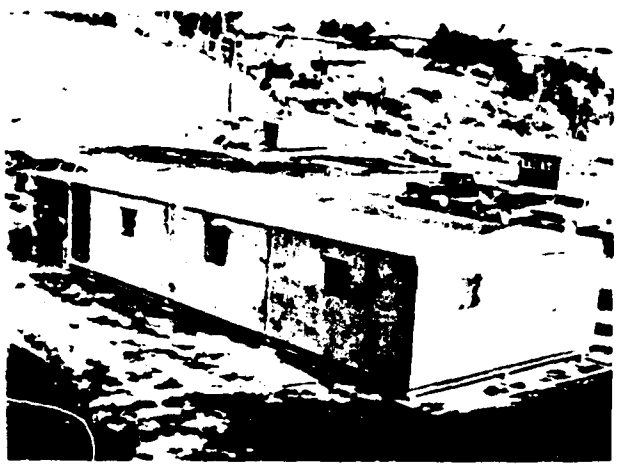
TWO SIDES EXPANDABLE

- 15,000 LB GROSS WEIGHT
- 45 MINUTES, 4 MEN ERECTION TIME

HIGHLY EXPANDABLE SHELTERS

(Class 3)

8x8x20 ISO



7 FOR 1 EXPANDABLE

- 8'Hx8'Wx19'11"L EXTERIOR
- 8'Hx50'Wx19'11"L EXT. EXPANDED
- PANELS SHIPPED IN CONTAINER MODE
- 11,500 LB TARE WEIGHT
- 6.5 HOURS, 4 MEN ERECTION TIME

KNOCKDOWN SHELTERS

(Class 7)

STORED

- 1'9"Hx8'Wx19'11"L KNOCKED DOWN
- 4 SHELTERS CAN BE TRANSPORTED IN 8x8x20 ISO MODE

8x8x20 ISO

ERECTED

- 7'1"Hx7'5" Wx19'L INTERIOR DIM.
- 6'2"H FLOOR TO BEAM
- 3650 LB TARE WEIGHT
- 45 LB/SQ. FT. FLOOR LOAD

(Exhibit 5)

STANDARD MILITARY FLEET LUBRICANT CREATES MANY OPERATIONAL AND COST BENEFITS

Purpose

This case study discusses the benefits of DOD standardization of tactical engine lubricating oil, the design efforts that result in commonality of products, and the payoffs associated with a standard military fleet lubricant.

Background

In the early 1940's, the U.S. Army issued Specification 2-104 which called for the use of standardized heavy-duty engine oil suitable for crankcase lubrication of reciprocating internal combustion engines for military ground equipment. Prior to this specification, standardized engine oils for military ground equipment were neither available or required. Military specifications have been progressively revised and expanded to meet the demands imposed by requirements of new, larger, higher output engines developed to satisfy operational and environmental needs of the services. In 1983, MIL-L-2104D was implemented specifying lubricating oils in three single viscosity grades (10W, 30, 40). The thinner grade, 10W, is used in colder climates (See Exhibit 1). The thicker grades, 30 and 40 are used in normal to very hot climates. A multiviscosity 15W-40 with a wide ambient temperature range is also specified. The private sector has, for some time, been using multiviscosity engine oils with both equipment producer and consumer satisfaction.

Problems

Many tactical vehicles and heavy equipment items are operated in geographic regions characterized by wide ambient temperature fluctuations which require seasonal oil viscosity changes and mandatory oil change intervals based on usage or lubricant condition. This imposed a burden on logistics support organizations in providing both the labor and lubricant to satisfy the temperature extremes.

The various procedures and service pecularities within the military supply systems have long indicated the need for commonality of products. Military Services procure and store a variety of engine and gear oils, automatic transmission and hydraulic fluids, greases, corrosion inhibitors, and specialty compounds. The potential for misapplication of these lubricants has adversely affected equipment maintenance and operation. For many years, the Army has unilaterally used 10W engine oil as an automatic and powershift transmission fluid as well as a hydraulic system fluid. This precedent, established by the Army, has shown positive results; however, payoffs have not been adopted by the Services except on a limited basis.

In wartime, standard lubricants are essential to maximize the operational availability of tactical ground equipment. In peacetime, the Military Services still need logistically available, quality, standard lubricants. Even though peacetime volumes are significantly reduced, oil products presented by various manufacturers for conformance with military specifications and standards have increased. To develop petroleum products for the Services, it is necessary to exceed the requirements established by commercial experience so that more stringent military requirements can be met. The oil quality that must be assured requires test procedures that would be costly if the government were to perform them independently.

Discussion Topics

1. Describe the benefits of maximum DOD application of MIL-L-2104D tactical engine lubricant on the battlefront, supply line, and the commercial market.

2. What benefits would be derived from government-industry cooperation on qualification and testing of lubricants?

Outcome

The April 1983 revision of MIL-L-2104D set forth the guidelines for lubricating oils for internal combustion engines used in tactical vehicles and equipment. The specification covers crankcase oils suitable for use in gasoline engines, diesel engines, automatic transmission, and hydraulic systems used in all types of tactical military ground equipment. Also, it establishes, for the first time, performance specifications criteria for lubricating oils intended for use in automatic transmissions and hydraulic systems.

The Services are working with industry groups to develop mutually acceptable procedures for qualifying, testing, and classifying new and existing products. The Society of Automotive Engineers (SAE), American Petroleum Institute (API), and the American Society for Testing and materials (ASTM) are three of these groups. The SAE Lubricants Review Institute (LRI) deals with the conformance to military standards of candidate products for approval by the U.S. Army which actively participates on the review committees. Engine manufacturers, other government agencies, and commercial vehicle fleet owners have benefited from, and continue to support the review process which provides oil quality assurance above and beyond the SAE/API/ASTM performance classification system. All parties recognize that sampling and evaluation by the U.S. Army provides conclusive approval of commercial oils recommended for their fleets.

There are three single viscosity grades (10W, 30 and 40) and one multiviscosity grade (15W-40) listed in the specification. The 15W-40 offers superior performance under all conditions and can be used year-round in environments which otherwise would require seasonal oil changes.

The multipurpose uses of MIL-L-2104D for military applications have grown as more automatic transmission vehicles and higher output engines and equipment items have entered the inventory.

Payoffs

The introduction of 15W-40 multigrade engine oil will eliminate the need for most seasonal oil changes in 273,025 tactical combat vehicles, resulting in projected cost savings of approximately $5.7 million per year. These projected cost savings were based on a 1981 TACOM economic analysis of the vehicles by reviewing annual costs using multiviscosity 15W-40 engine oil changed once per year (see Table A-1).

Table A-1

	Cost of Oil	Filter Cost Diff/Veh.	Cost of Labor 12.41/Hr	Final Cost/Year
Two Oil Changes 30	(1.89/Gal) 5,003,733	2,244,060	4,982,789	12,230,582
One Oil Change 15W-40	(2.20/Gal) 2,912,226	1,122,030	2,491,394	6,525,650
			Projected Cost Savings =	5,704,932

Minimizing the variety of required fleet lubricants creates simplified inventory procedures and less chance of misapplications and resultant equipment damage. The multipurpose uses of MIL-L-2104D specified lubricants have shown intangible cost reduction benefits in these areas.

As evidenced by the number of producers on the Qualified Products Listing (81), competition has been enhanced by the use of a standardized lubricant with broad applications.

The Army evaluation of candidate oils coupled with industry's qualification and testing procedures has resulted in great cost savings to the government. This cooperation between government and industry continues to benefit both communities.

Current Status

MIL-L-2104D is approved for use by all the Services with the greater concentration of usage being in the Army and Marine Corps. The new M939 series 5-ton truck provides a good example of the service-wide use of the multipurpose applications of the lubricant. In specified viscosity grades, 21.5 gallons of MIL-L-2104D are used in the truck for engine, transmission, and hydraulic fluid applications. The Marine Corps' TEREX tractor (rubber tired) contains 33 gallons of MIL-L-2104D specified lubricants for similar applications.

Topics For Further Discussion

Prepare a model for Tri-Service standardization of military fleet lubricant.

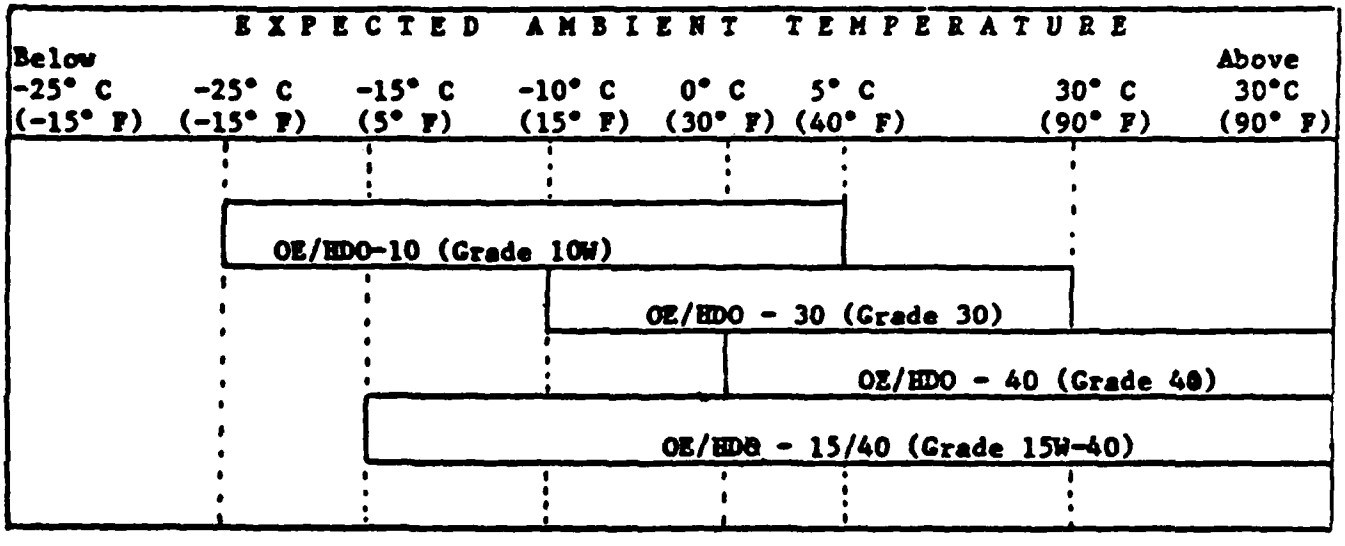

EXPECTED AMBIENT TEMPERATURE
Below -25° C (-15° F)
-25° C (-15° F)
-15° C (5° F)
-10° C (15° F)
0° C (30° F)
5° C (40° F)
30° C (90° F)
Above 30°C (90° F)
OE/HDO-10 (Grade 10W)
OE/HDO - 30 (Grade 30)
OE/HDO - 40 (Grade 40)
OE/HDO - 15/40 (Grade 15W-40)

Exhibit 1

AMMUNITION INTERCHANGEABILITY ON BATTLEFRONT ENHANCES COMBAT CAPABILITY

Purpose

This case study summarizes the North Atlantic Treaty Organization (NATO) standardization programs for small-caliber ammunition, 5.56-mm, 7.62-mm, 9-mm, and 25-mm cartridges and highlights significant tactical, strategic, and logistic benefits of the programs.

Background

Allied forces suffered diminished combat capability during World War II due to lack of small-caliber ammunition standardization. Lessons learned in World War II led to the military standardization policies of the North Atlantic Treaty which proclaimed that an armed attack against one or more of the allies shall be considered an attack against them all and called for the exercise of "collective self defense". In the supply and maintenance of infantry forces, priority was given to interchangeability of ammunition as one of the most basic NATO policies. NATO, through standardization, attempts to achieve the closest practicable cooperation among member nations and to operate together in the most efficient and economical manner.

Problems

In the 1950's, the NATO community sought to reduce the large number of existing small-caliber ammunition types and to prevent the development of non-interchangeable designs. An organized standardization system was required for long term interchangeability and production of NATO ammunition to provide the Armies with mutually supportive ammunition stocks. The cost-budget squeeze in NATO countries, caused by competing domestic priorities and increasing R&D, procurement, and man-power costs, added economic incentives to existing military incentives to achieve more effective and efficient uses of collective national resources. Considering independent military requirements of member nations, in addition to geographic and language differences, the task of standardizing would be difficult.

Discussion Topics

1. List the pro's and con's of NATO standardization of small-caliber ammunition from the U.S. point of view, including industry reactions.

2. How might the interchangeability of NATO approved rounds be assured?

Outcome

In pursuit of the NATO objectives, the U.S. Army participated in a series of conferences with the allied nations, the outcome of which was the selection, in 1957, of the 7.62-mm cartridge as the "NATO rifle caliber". A standard drawing was produced (Exhibit 1) along with a standardization agreement, STANAG 2310. The NATO Small Arms Ammunition Panel was formed with the responsibility for managing the implementation of STANAG 2310 and whatever additional agreements might be developed and ratified for small-caliber ammunition. Test centers were established in the U.S. and Europe to ensure compliance with the NATO standard designs through a series of intense qualification approval, production, and surveillance tests. Qualification approval tests serve to qualify a design and to establish interchangeability. Production tests are performed semi-annually on a random sampling of the preceding six months production to establish that ammunition produced to a qualified design has continued to meet prescribed criteria. Surveillance tests establish the continuing serviceability of ammunition with samples taken at four-year intervals. Ammunition meeting the above criteria will bear the NATO symbol of interchangeability (Exhibit 2) on the outer side of the containers. This system provides a mechanism to assure continuing standardization and interchangeability of small-caliber ammunition. When decisions are made to standardize additional infantry weapon systems, the proven procedures are available to facilitate and expedite new standardization programs.

A typical general reaction of many industry representatives to the idea of NATO ammunition standardization is a strong insistence on the merits of "making and selling our own product - we can do it best" (parochial attitude). This implies a kind of built-in opposition or resistance to cooperative production arrangements. But there also appears to be growing awareness in industry that the character of the world economy has changed in recent years and it is no longer realistic to think in terms of an assured, preeminent Nationalistic position in the international market. Over the long haul, total ammunition production is likely to be greater, with consequent greater profits for participating industry.

Payoffs

NATO standardization programs for small-caliber ammunition have been very successful. These programs have allowed the interchangeability among all NATO countries of many infantry weapons systems, including 5.56-mm, 7.62-mm, 9-mm, and 25-mm, pistols, rifles, machine guns, and automatic cannons, and more than 40 cartridge and 25 weapon designs. The ammunition is fully interchangeable with no degradation in reliability, effectiveness, and safety. Vast multinational stockpiles are available in the above sizes. The testing and approval processes prevent the inadvertent introduction of non-interchangeable ammunition to the inventory, and provide for the removal of no-longer interchangeable ammunition from the inventory.

On the battlefront, firing units from allied countries can now supply each other without fear of incompatibility, despite the fact that the various weapons may be dissimilar with respect to the design and type of operation. Exhibit 3 depicts the magnitude of the 7.62-mm program with a listing of some of the interoperable weapons. Also shown are design variabilities of these weapons. This exhibit illustrates several of the technical differences addressed in this program.

A noteworthy benefit within the industrial community is the exchange of technology among nations. Although the basic technology used has been available, small arms ammunition designs are much more complex than they might appear. NATO agreements provide a highly effective means of transferring complex technology to overcome design problems.

The cost to the U.S. for engineering and hardware support of the standardization program is approximately $450,000 per year. This will allow continued participation on the NATO Small Arms Ammunition Panel, operation of the test centers, and implementation of all STANAG's covering small-caliber and automatic-cannon caliber ammunition by the U.S. Travel and documentation costs on the average, are less than 5 percent of the annual funding or approximately $20,000 per year. This is undoubtedly a small price to pay for a "mechanism" to continuously maintain ammunition interchangeability, to add to it, and to extend it to other calibers.

Current Status

The willingness to achieve standardization and maintain multinational cooperation has been demonstrated. The U.S. has recently ratified the use of a Belgian designed 5.56-mm cartridge. This cartridge, with its heavier bullet, has increased effective range and penetrative power. The new M16A2 combat rifle, designed to accommodate the 5.56-mm NATO cartridge, has been adopted as a standard for U.S. Forces.

The NATO standardization agreement (STANAG) covering the 25-mm cartridge is in the process of being ratified by the U.S.

More than 15 billion rounds of fully interchangeable ammunition have been made available for joint military operations by 15 countries.

Problems In Effecting A Solution

Technical issues have developed concerning the hardness of the cartridge casing. Controlled metallurgy of the casing is required to ensure proper operation of all NATO approved ammunition.

Topics For Further Discussion

1. Ammunition is purchased in such large quantities that one of the usual benefits of standardization-cost savings from greater competition and economies of scale do not exist here. List at least 5 other benefits of standardization of ammunition.

2. Develop the steps required for complete standardization and interchangeability of NATO small-caliber ammunition.

NOTE : Only the drawings in inches must be considered as valid in relation to STANAG No. 2310. These drawings converted into the metric system are annexed for information only.
Conversion factor used : 1 inch = 25.400 mm

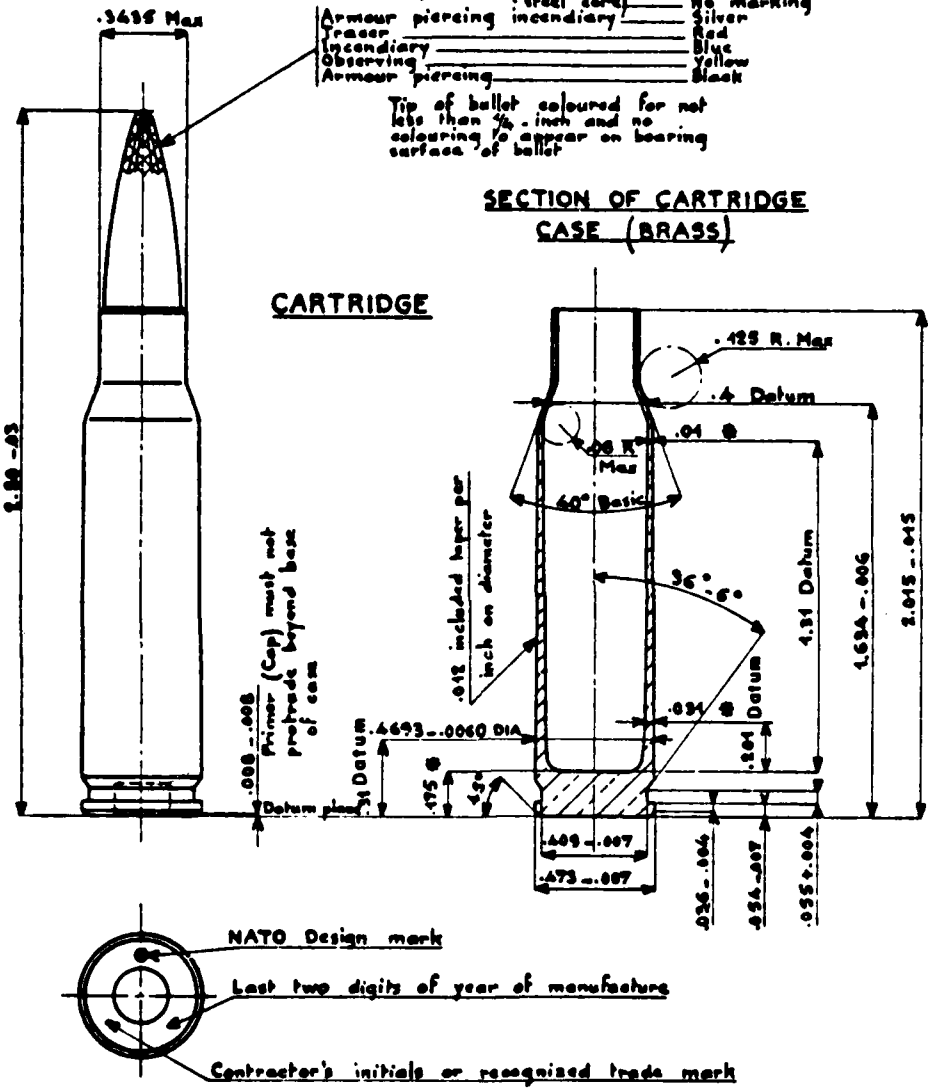
ANNEX "A" SHEET 1
to STANAG - 2310 (Edition No 3)

Extractive effort
Minimum = 60 Pounds

-Bullet tip marking-

General purpose (Lead or mild steel core) ——— No marking
Armour piercing incendiary ——— Silver
Tracer ——— Red
Incendiary ——— Blue
Observing ——— Yellow
Armour piercing ——— Black

Tip of bullet coloured for not less than ¼ inch and no colouring to appear on bearing surface of bullet



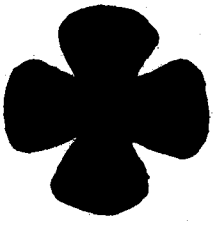
-NOTES-

-1- The tolerance on any angle shown untoleranced is derived from the associated linear dimensions
-2- An included taper not to exceed .002 inch. is allowable in neck due to variable expansion of brass
-3- Eccentricity between rim and the maximum diameter of the .012 inch taper cone must not exceed .001 inch (.002 inch full indicator reading)
-4- Ⓜ Dimension for guidance only

STANDARDIZATION DRAWING
7.62 -MM CARTRIDGE
Scale : 2 : 1
Dimensions are in inches
Reproduced from original drawing to a smaller scale

Prepared by D.T.A.T. St CLOUD. FRANCE

(Exhibit 1)



NATO SYMBOL OF INTERCHANGEABILITY

(Exhibit 2)

7.62-mm CARTRIDGE INTERCHANGEABLE WEAPONS

Canadian C1 Rifle
UK L1A1 Rifle
Belgian FAL Rifle
FRG G3 Rifle
U.S. M14 Rifle
Itailian BM59 Rifle
U.S. M60 Machine Gun
U.S. M60E2 Tank Machine Gun
French AA1952NF1 Machine Gun
UK L7A2 Tank Machine Gun
Belgian MAG 58 Machine Gun
FRG MG3 Machine Gun
FRG MG42 Machine Gun
U.S. Minigun
Cal. .30 Machine Guns Converted to 7.62-mm cartridge by Canada
Mauser and Enfield Rifles Converted to 7.62-mm cartridge

WEAPONS TECHNICAL DIFFERENCES

Self Powered
Externally Powered
Gas Operated
Recoil Operated
Blowback Operated
Mass-Retarded Blowback Operated
Positive Locking
Mass Locking
Fluted Chambers
Smooth Chambers

(EXHIBIT 3)

STREAMLINING AND TAILORING STANDARDS AND SPECIFICATIONS PAYS OFF FOR NAVY T45TS JET FLIGHT TRAINING SYSTEM

Purpose

There is little appreciation for the significant impact that standards and specifications have on program cost. Faced with the challenge to reduce program costs from $727 million to $450 million or face cancellation, the T45TS program attacked every cost driver. Standards and specifications proved to be a particularly fruitful area.

Background

The Navy's T45 Training System is a comprehensive, integrated, jet flight training system for intermediate and advanced Navy and Marine pilots. It is a derivative of the British land-based Hawk system redesigned to include aircraft carrier capability. See Figure 1. The T45TS package will ultimately include procurement of 300 aircraft, 32 simulators, 49 computer-based training integration systems for a total acquisition cost of $3.2 billion in FY 1984 funds. This integrated training system will be used to train approximately 600 jet pilots per year. The initial operational capability date is October 1990. Full-scale engineering development was to start in October 1984.

Problem

The competitive contract for demonstration/validation phase of the T45TS was awarded to Douglas Aircraft Company. The follow-on effort associated with Full-Scale Engineering Development (FSED) was estimated by the contractor to be approximately $810 million. Early Navy restructuring of T45TS reduced initial FSED cost estimates by about $83 million to an estimated $727 million. Subsequently the Navy Systems Acquisition Review Council and the Secretary of the Navy determined that, while the FSED acquisition strategy was sound, it was not affordable. The program would be indefinitely postponed unless it could be brought in as a firm fixed price contract of no more than $450 million. The T45TS Program Office and the contractor team had just a few months to restructure the program; achieve cost savings and cost avoidance wherever possible; and maintain the technical and operational capabilities of the system. Nothing was taken for granted. "Tiger Teams" focused on all aspects of the program resulting in major changes in logistics support, cockpit displays, situation simulator, flight test program, and many other aspects of the program. Costs were reduced significantly by using existing designs for both the engine and ground equipment. Intuitively, the program office and the contractors recognized that potential savings might be significant in the areas of specifications and standards, and contract data requirements. However, these elements were basic to system definition and were pervasive in every subsystem and component of the T45TS. Tiger Teams that addressed subsystems such as hydraulics or avionics were reluctant to challenge the standards and specifications that had been invoked on generations of Navy systems.

Discussion Topics

1. Are there occasions when a specification or standard can be applied for just informational purposes or guidance?

2. Does every referenced document become a contractual requirement? What is the status of documents referenced within referenced documents?

3. What kinds of data does the Government require from a contractor? Why are these necessary?

4. Why does the Government specifically define the format and content of specifications and other data items?

Outcome

To wring all potential savings from standards and specifications and contract data requirement the T45TS Program Manager established a Navy/contractor Tiger Team. The team was charged to streamline specifications and standards by determining minimum essential technical requirements without sacrificing material needs and particularly to isolate essential performance requirements from detailed design requirements. Because the T45A aircraft was derived from the proven British Aerospace Company (BAe) Hawk aircraft, the team concentrated on the Navy's T45A Aircraft Detail Specification. Nearly 80 percent of overall system cost was in the aircraft.

The T45A Aircraft Detail Specification (like all similar equipment documents) defines all the operational characteristics of the aircraft and its subsystems, as well as proven practices that are to be applied in the design, manufacture, and support of the aircraft. As originally prepared, many requirements of the Aircraft Detail Specification required "Americanization" of British practices and processes. The standards and specifications Tiger Team applied the tailoring principals of DOD-HDBK-248 and developed the following strategies to accomplish their goal:

a. Limit the contractor's obligation for specification compliance only to the second tier level of referenced documents for non-critical components and the third for critical, safety of flight, components. This was possible because of the derivative nature of the T45A Aircraft.

b. Examine existing specification applications to determine which could be candidates for 1) deletion, 2) additional tailoring, 3) use by the contractor for guidance purposes only to meet the design intent that the particular specification imposed.

Closely associated with this specifications and standards streamlining initiative was reduction of contractor data submittals referenced in the Contract Data Requirements List (CDRL). This task was assigned to the T45TS Program Data Manager and the contractor's Data Manager. They took into account the impact that the streamlining process had on engineering documentation; the types, quantities, and format of data to be delivered by the contractor, along with the need to formulate a management philosophy that could be applied consistently to the entire system. In determining the data requirements which could actually be imposed, the following strategies were developed in addition to those applied to standards and specifications:

a. Utilize existing data (British design documentation, test data, drawings, etc.) where possible for areas common between the T45A and BAe HAWK MK53 Aircraft. This approach was considered acceptable provided nc redesign would occur to the affected area. If redesign did occur, a data submittal would be required and the format (existing vs. Navy) would be determined on a case-by-case basis. This strategy was particularly significant because it required Navy and Contractor engineer to interpret, evaluate, and resolve different engineering philosophies, application, and drawing practices utilized by the British aerospace industry to determine if these procedures would fulfill the Navy's need.

b. Combine common data requirements specified at the subsystem level (aircraft, ground training system, integrated logistics support) into a single "system" data deliverable that would address each subsystem requirement in one document. This strategy was particularly significant to the contractor for ease of accounting and data management tracking.

c. Eliminate "gold-plating" of contract data by deleting requirements that were not needed by the Government and limiting the number that required Government approval. In most cases changes would evolve within the Tiger Team as Government and contractor personnel mutually weighed program requirements against true costs.

d. Allow contractor format for the preparation of data deliverables to the maximum extent possible to aid in reducing the contractor's administrative development efforts. Government position, in most cases, was that the format of the data was unimportant provided the technical content was complete enough to do a thorough evaluation.

Payoffs

A typical aircraft development program includes references to an estimated 6000 specifications and standards. The T45A references 350, of which 281 are contractually invoked. These are summarized in Table I. Approximately twenty percent of the documentation consists of British engineering standards and related documents. These primarily define manufacturing and finishing processes.

Total overall data requirements were reduced from 530 to 251. Approximately 20 were combined at the "system" level and 142 of the total were allowed to be submitted in the contractor's format. Table II shows the results of the contract data restructuring effort. A large portion of these requirements in the T45A area (Exhibits B, F and G) may not require a data submission if no redesign occurs because existing data is sufficient to delineate the design.

Streamlining and tailoring standards, specifications, and contract data requirements resulted in considerable cost avoidance throughout the program. Because standards and specifications pervade the entire system and, because actual data costs were not identified, a specific figure cannot be established that accurately represents cost avoidance from just this effort.

Standards and specifications are critical to the definition of nearly every element in the system's work breakdown structure. Savings or cost avoidance were realized by each of the Tiger Teams as they applied the strategies formulated to control and reduce the cost of specifications, standards, and contract data requirements. These tangible benefits are included among the numerous economies realized in design, test, and logistics. Intangible benefits accrued as well. Schedules could be shortened because new documents did not have to be created. Engineers could apply more of their time to solving engineering problems rather than converting British documents to American formats. Finally, a very rewarding but intangible payoff was mutual agreement and understanding between Government and contractor of T45TS program requirements and content.

The Government developed an appreciation for the contractor's technical approach and business practices, while the contractor developed an appreciation of how the Government structures its program requirements. This understanding proved to be extremely important and helped set the stage for effective Tiger Team deliberations and subsequent contract negotiations.

Current Status:

Engineering developement was authorized in October 1984 when the contractor entered into a firm fixed price contract for $438 million. An assessment of overall risk from program restructuring, including specification tailoring and streamlining, arrived at the following conclusions:

RISK	BEFORE RESTRUCTURE	AFTER RESTRUCTURE
TECHNICAL	LOW	LOW
SCHEDULE	LOW	MODERATE
CONCURRENCY	MODERATE	LOW
FINANCIAL		
GOVERNMENT	MODERATE	LOW
CONTRACTOR	LOW	MODERATE

Problems in Effecting a Solution

The concept of streamlining contract requirements to reflect only the minimum essential material needs, and yet maintain program content, concurrency, and schedule was extremely difficult to implement. Four major problem areas had to be overcome in order to make the T45TS program restructuring process successful:

1) Convincing functional personnel to develop innovative, new, and less restrictive approaches for achieving technical requirements. Many of the specifications, standards, and data requirements originally referenced (before streamlining) were based upon years of lessons learned by the Government from other programs and the attitude that "this is what we always require in a development program". Additionally, functional personnel were reluctant to disclose their bottom line requirements and consequently "protected their rice bowls".

2) Crossing over the invisible barrier that typically exists between Government and contractor. In order to instill a team concept in reaching a common goal, adversarial relationships cultivated by years of Government/industry interaction had to be shed. Both sides were forced to mutually trust and respect the other, attacking the technical problems without allowing personalities or divergent opinions to stand in the way.

3) Overcoming the "language" barriers that existed between Government and contractor. The Government addressed issues by contract line item, while the contractor utilized the Work Breakdown Structure (WBS). Since the WBS defined requirements in a more detailed manner than the contract line items, Government personnel were required to learn and use WBS language.

4) Acceptance by contracting and pricing personnel of the technical negotiations concept. Both groups had to share closely held cost estimates to get agreement on the cost of each major element in the WBS. This was a highly iterative process that required eleven different sessions to restructure the WBS and establish a new cost estimate for the program.

All of these problem areas were resolved by the Tiger Team coordinators. By encouraging teamwork, acting as arbitrators, negotiating stalemates, and protecting the team from possible disruptive outside inputs, the coordinators instilled cooperation and control throughout the restructuring process. Separate Government and contractor caucuses were held periodically to remind Tiger Team members of the task at hand, and to promote the teamwork concept. Without the coordinators' control and constant encouragement, the successful restructuring of the T45TS program would not have been achieved.

Topics for Further Discussion

1. Cite five different reasons for invoking standards or specifications.

2. Provide examples of three types of "gold-plating" that might show up in specifications and three types among Contract Data Requirements. How do gold-plated requirements come about?

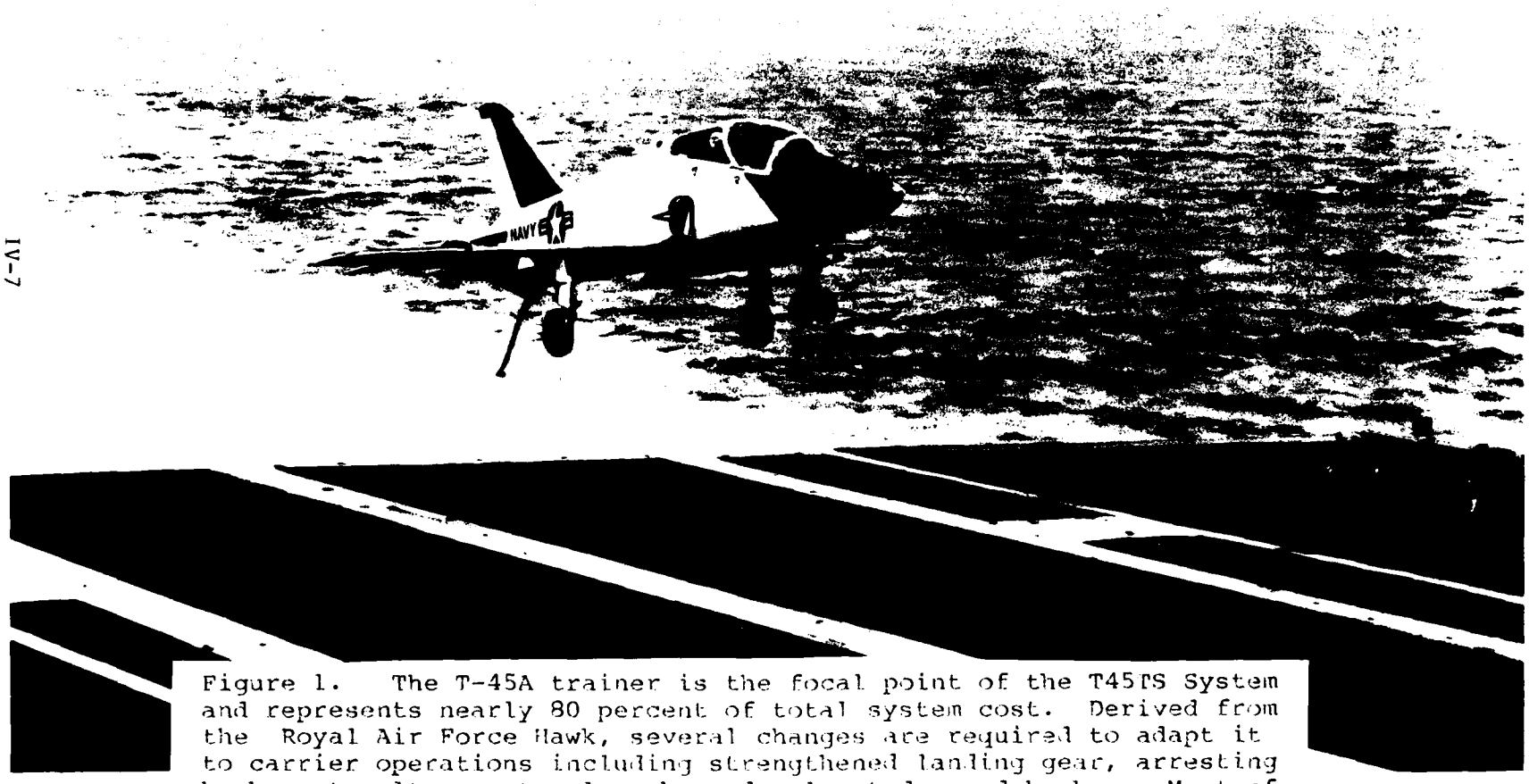


Figure 1. The T-45A trainer is the focal point of the T45TS System and represents nearly 80 percent of total system cost. Derived from the Royal Air Force Hawk, several changes are required to adapt it to carrier operations including strengthened landing gear, arresting hook, catapult nose-tow launch, and relocated speed brakes. Most of these modifications are visible in this illustration

TABLE I

T-45A AIRCRAFT DETAIL SPECIFICATION
APPLICABLE DOCUMENTS BREAKDOWN

DOCUMENT	QUANTITY	PER CENT	NO. OF TIMES REFERENCED	PER CENT
DEPARTMENT OF DEFENSE				
FEDERAL SPECIFICATIONS	8	2.3	8	1.6
MILITARY SPECIFICATIONS	145	42	231	46.1
FEDERAL STANDARDS	1	**	2	**
MILITARY STANDARDS	37	10.1	53	10.5
MIL.STANDARD DRAWINGS (MS)	28	8.1	29	5.7
MILITARY HANDBOOKS	6	2	7	1.3
MILITARY BULLETINS	2	**	2	**
AIR FORCE-NAVY AERONAUTICAL STANDARDS (AN)	1	**	1	**
AIR FORCE-NAVY DESIGN STANDARD DRAWINGS (AND)	1	**	1	**
AIR STANDARD COORDINATING COMMITTEE (ASCC)	1	**	1	**
NAVAIR AND OPNAV DOCUMENTS	20	6	23	4.5
NATO STANDARDIZATION AGREEMENTS (STANAGS)	3	**	3	**
OTHER GOVERNMENT DOCUMENTS				
FEDERAL AVIATION	1	**	2	**
NONGOVERNMENT STANDARDS				
AIA NATIONAL AEROSPACE STANDARDS (NAS)	16	5	17	3.4
SAE AEROSPACE MATERIALS SPECIFICATIONS (AMS)	5	1.4	5	1
RADIO TECHNICAL COMMISSION FOR AERONAUTICS (RTCA)	3	**	3	**
AMERICAN SOCIETY FOR TESTING & MATERIALS (ASTM)	1	**	1	**
AECMA STANDARDS (prEN)	1	**	2	**
INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)	1	**	1	**
	281		392	

** Less than 1 percent

Table I - continued

EXISTING DOCUMENTS CONSIDERED ACCEPTABLE BY THE GOVERNMENT

IN LIEU OF DOD MILITARY-SPECS AND STANDARDS

DOCUMENT	QUANTITY	PER CENT	NO. OF TIMES REFERENCED	PER CENT
DOUGLAS PROCESS STANDARDS	2	**	2	**
BRITISH GOVERNMENT DOCUMENTS	21	6	34	6.7
BRITISH AEROSPACE (BAe) DOCUMENTS	39	11.3	49	9.8
SOCIETY OF BRITISH AEROSPACE COMPANIES (SBAC)	5	1.4	10	1.9
ROLLS-ROYCE LIMITED	1	**	13	2.6
ROYAL ORDNANCE FACTORY (ROF)	1	**	1	**
	69		109	

** LESS THAN 1 PERCENT

Table II

T45TS CONTRACT DATA REQUIREMENTS REDUCTION

CONTRACT EXHIBIT	EXHIBIT TITLE	ORIGINAL NUMBER	CURRENT NUMBER	CONTRACTOR FORMAT
A & K	INTEGRATION & MGMT.,T45TS	34	27	11
B	T-45A AIRCRAFT DATA	180	76	37
C	T45TS FINANCIAL DATA	12	8	0
F	ENGINEERING INVESTIGATIONS AND TESTS, T-45A AIRCRAFT	68	43	38
G	FLIGHT DEMONSTRATION T-45A	11	8	7
H	RELIABILITY & MAINTAINABILITY, T-45A AIRCRAFT	37	14	4
J	TIS FUNCTIONAL DESIGN	15	3	2
NEW K	RELIABILITY & MAINTAINABILITY, SIMULATOR, TIS, ACADEMICS	6	2	0
L	TIS ENGINEERING DATA	26	8	1
M	ACADEMICS ENGINEERING DATA	49	6	4
N	IUT COURSE, CAI	4	4	3
Q	OFT ENGINEERING DATA	42	13	1
R	MOCKUPS	2	2	0
T,U,V, W,X,Y,	INTEGRATED LOGISTICS SUPPORT	43	39	34
	T O T A L S	530	251	142

THE DISCIPLINE OF DEVELOPING A STANDARDIZED SYSTEM PAYS OFF IN MANY AREAS

Purpose

While "off-the-shelf commercial equipment" can often provide the most effective solution to a design problem, there are occasions when commercial equipment is neither the most cost effective nor sufficiently reliable. Personal injuries focused attention on reliability and safety problems with winches for the Fleet's underway replenishment systems. Logistics problems were also identified. A comprehensive standardization program solved these problems and yielded significant cost reductions as well.

Background

During the 1960's and early 1970's, the Navy built a Fleet of 34 underway replenishment (UNREP) ships to sail with Aircraft Carrier Battle groups. UNREP ships transfer fuel, ammunition, and stores to aircraft carriers and destroyers whenever needed while the ships are underway day or night. Each UNREP ship was originally outfitted with 20 to 45 commercial-type winches for transfer of cargo at sea.

Cargo is transferred via a tensioned wire rope called a highline which acts as a "railroad track" for a trolley to carry the cargo load between ships. See Figure 1. The highline is kept taut and within safe design limits through automatic ram tensioners while the two ships roll and heave in the ocean's waves. This is not feasible, however, for the hauling winches. Complex servo controls were built into these winches to sense and compensate for the relative motion between ships while hauling heavy and dangerous loads and even personnel.

Refueling at sea uses a similar system to support a 300-foot long seven inch diameter hose from one ship to another. A series of saddle blocks replace the trolley. These saddle blocks are controlled by winches that do not have the same requirements for tension control as hauling winches because the flexible fuel hose can be rigged to provide adequate slack. See Figure 2.

The new fleet of underway replenishment ships had 248 tensioned highline rigs installed, each of which included two hauling winches - an inhaul and outhaul- and two or three saddle winches. A pair of hauling winches typically cost more than $400,000. Shipyards could install winches of their choice as long as they met the applicable performance specification. Ultimately, a total of five different hauling winch designs, as well as seven different saddle winch designs, were installed in the fleet to perform identical functions.

Problems

While commercial winches had proved satisfactory in many shipboard applications, the requirements of underway replenishment exceeded the design capabilities of off-the-shelf equipment. The servo controls exacerbated an already difficult situation. Each of the five different types of hauling winches had complex hydraulic servo and electronic feedback systems. Troubleshooting and control adjustments were no longer within the capability of maintenance personnel. Each design had its unique requirements for spare parts. This complexity compounded

existing reliability problems. Many of these problems resulted from inadequate design margins in the commercial winches for the rugged duty-cycles and environment of underway replenishment. These deficiencies frequently prevented the underway replenishment machinery from performing as planned or working when needed. Most serious were winch problems which caused wire ropes to break. Not only were valuable cargoes lost, and ships damaged, but seamen were seriously injured. Underway replenishment systems got top Navy attention as problems accumulated with commercial winches. Office of Chief of Naval Operations halted further purchase of commercial winches for underway replenishment systems.

Discussion Topics

1. List five advantages and five disadvantages to buying commercial off-the-shelf equipment.

2. Provide five examples of products used by DOD that can be bought off-the-shelf with low risk, and five that would be high risk.

3. How can the same set of spare parts ever be appropriate for equipment purchased form different suppliers? How can the quantity of different spares be limited to a reasonable number?

4. What acquisition strategy or specification practice could assure receipt of a reliable standard product?

Outcome

An -in-house Navy design team was established to develop winches specifically for the application. These were to be safe, rugged and competitively procurable. One of its first tasks was to re-evaluate system requirements to identify any areas where performance capability could be reduced while maintaining satisfactory delivery levels at sea. High priority was placed on:

- developing simpler controls for those winches equipped with electronic/hydraulic systems;
- preparing Navy-owned design data packages suitable for competitive procurement;
- improving maintainability by standardizing, as much as possible, components used on various items of machinery that make up the system;
- improving reliability by using proven existing standard components wherever possible, and simplifying and making existing designs more rugged.

Navy designers studied the track record of all winches, related rigging and deck machinery in service with the Fleet. This study identified those components that might be tough enough for the family of standard underway replenishment systems that were being developed. Analysis of saddle winch applications indicated that a much smaller and simpler winch should be able to meet all system requirements. Demonstrations at sea under harsh environments proved this analysis to be correct. The most complex and critical items in underway replenishment systems, the tensioned hauling winches, had all proven inadequate. One feature they all had in common was hydraulic servo and electronic feedback systems to control tension via a hydraulic transmission. A primary goal of the Navy design team was to replace these complex systems with mechanical systems that would simplify operation and maintenance.

An innovative design was conceived based on the sportsfisherman's deep sea fishing reel. These reels incorporate a "star drag" clutch which can be adjusted so that tension never exceeds the breaking strength of the fishing line. This design enables fishermen to land a big fish with light fishing line. The Navy adaptation separated the wire rope drum from its drive shaft by a slipping air clutch. By varying air pressure to an inner tube behind the clutch friction surfaces, winch drum torque could be regulated to produce an infinite range of wire rope tensions. Another major advantage of this design was the ability to combine two air clutch controlled winch drums with one transmission. The transmission operates continually while the air pressure in the winch drum clutches is adjusted. Equal pressure in both winch drums keeps the trolley stopped with the two wire ropes taut despite relative ship motions. A difference in pressure between the two air clutches pulls the loaded trolley between ships.

Production drawings were necessary if the Navy was to buy identical equipment with interchangeable parts from different manufacturers. Detailed production drawings were prepared for all items that were to be fabricated. Standard parts were used wherever possible. If these did not exist, proven vendor items were defined by source control or specification control drawings. Prior to adopting designs as the Navy standard, components were mocked-up and tested. Winch designs were proofed by building a winch of each type under close

monitoring by the designers. Finally a procurement specification was prepared that tied together all elements of the underway replenishment systems including appropriate quality assurance and inspection provisions.

Complementing this design and test effort, the Navy design team prepared technical manuals and spare parts lists to assist in maintaining the equipment. Guidance drawings were prepared for installing the new machinery on ships that were in service. The Navy team continues to maintain configuration control, and implement approved changes to upgrade the equipment, reduce costs, or improve delivery.

Payoffs

All objectives of this project were realized: underway replenishment systems, and in particular their winches, are now safer, more rugged, and are being procured competitively. Cost savings were not a project requirement but a fall-out of the Navy's design approach. The availability of Navy production drawings eliminates the need for a prospective contractor to have design departments and development labs. This enables small machine shops to compete. Competition has reduced overall acquisition costs by more than 10 percent as shown in Figure 3.

The data packages that define the Navy's Standard Underway Replenishment Machinery include complete production drawings. There can be no misunderstandings about the end products. Every contractor that follows the drawings builds identical machinery. Interchangeability within the machinery enables the variety of spare parts to be held to a minimum.

A major reduction in overall system cost results from the creative "star drag" design of the Navy standard hauling winch which does the job of two of the original commercial-type hauling winches. The smaller and simpler standard saddle winches are one-fourth the cost of traditional winches.

Navy standard winches need less maintenance which is a cost savings for life. Navy standard winches use many of the same components which reduces the Navy spare parts inventory. Navy standard winches also minimize the training needed by sailors and shipyard workers. Advantages from standardization due to fewer technical manuals, less training, and a much smaller range of spare parts are just beginning to be appreciated.

During the period 1985-1990 planned procurements of underway replenishment systems are estimated to total $125 million. If traditional commercial machinery had been used, costs would exceed $175 million. At least $50 million in cost avoidance are attributable to development of standard equipment and systems. Total project costs, including the acquisition of prototype equipment which was subsequently installed in the Fleet, were $5.5 million resulting in a return on investment of 9:1.

The actual design and development cost for Navy standard underway replenishment systems was less than one-third of the original budget. This was because of severe budget reductions during the first half of the project which were met by new program approaches which had technical risks. The designers overcame these risks because their expertise in underway replenishment helped them develop key solutions on the first try. Also they had some good luck on their design

decisions. Additionally the project had to be stretched out from five years to eleven years because of the budget cuts.

Current Status

Today new ships are outfitted and older ships retrofitted with standard underway replenishment systems. No wire ropes have parted where standard hauling winches have been installed and all standard winches used in these systems have significantly improved reliability. An evaluation of a prototype standard system onboard an ammunition ship included the following report: "... after more than four years service, reliability and maintainability of the prototype Navy standard winches are significantly superior in all respects as compared to commercial-type winches at the other three stations. Operational performance is better and the standard winch is noticeably safer .... The Fleet needs more simple, rugged and safer machinery like that at USS Pyro station 7 (the standard system)."

The winches designed for this project were evaluated in a government-wide competition sponsored by the National endowment for the Arts. Of 631 entries, this was one of 91 selected to receive a Federal Design Achievement Award.

Problems in Effecting a Solution

The "star drag" clutch concept was considered so unconventional that it was initially rejected on technical grounds. It took many years of successful operation of prototype Navy standard winches by the Fleet before the new design principles for these winches began to receive acceptance by the winch engineering community.

The eleven years of engineering development and shipboard experience that went into the standard hauling winch design was caused primarily by the radical design concept. Other equipment has been developed or converted to Navy standard design packages in much shorter time because they were essentially product improvements of existing designs.

Topics for Further Discussions

1. Are there any procurement techniques that can be used to limit the variety of similar equipment bought for a Service? a Base? a geographical area? a fleet? a unit within a fleet? Describe the options available in each case.

2. How can competition be fostered while at the same time standardizing on a proven, reliable product?

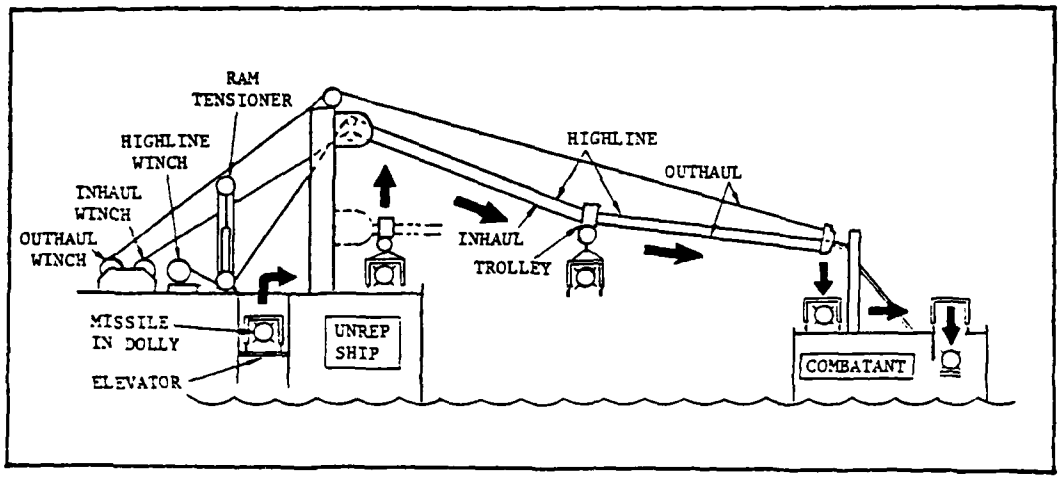


FIGURE 1

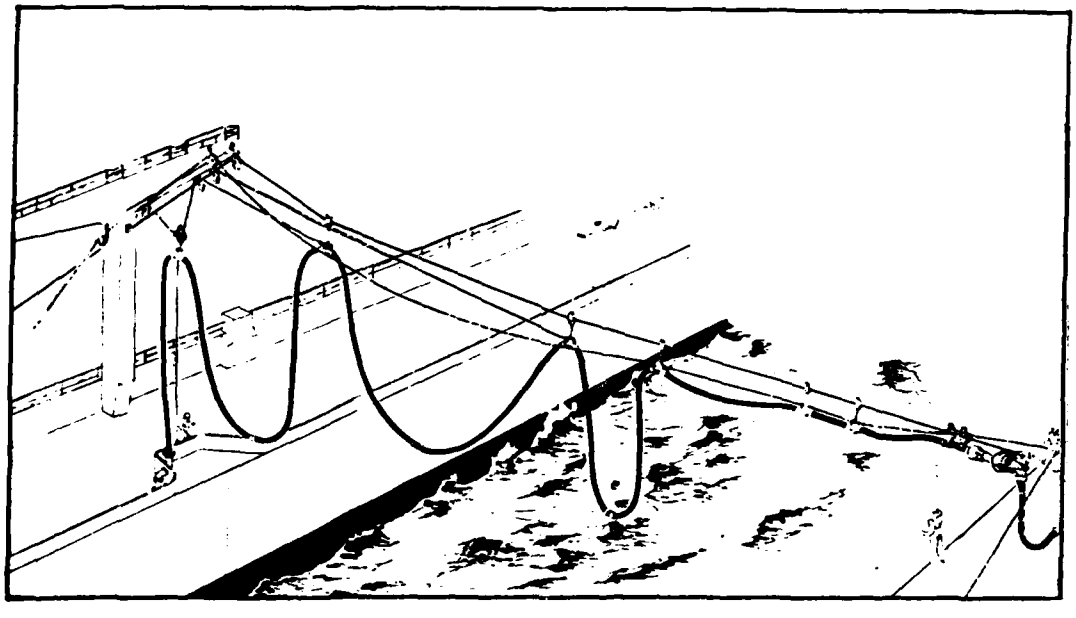


FIGURE 2

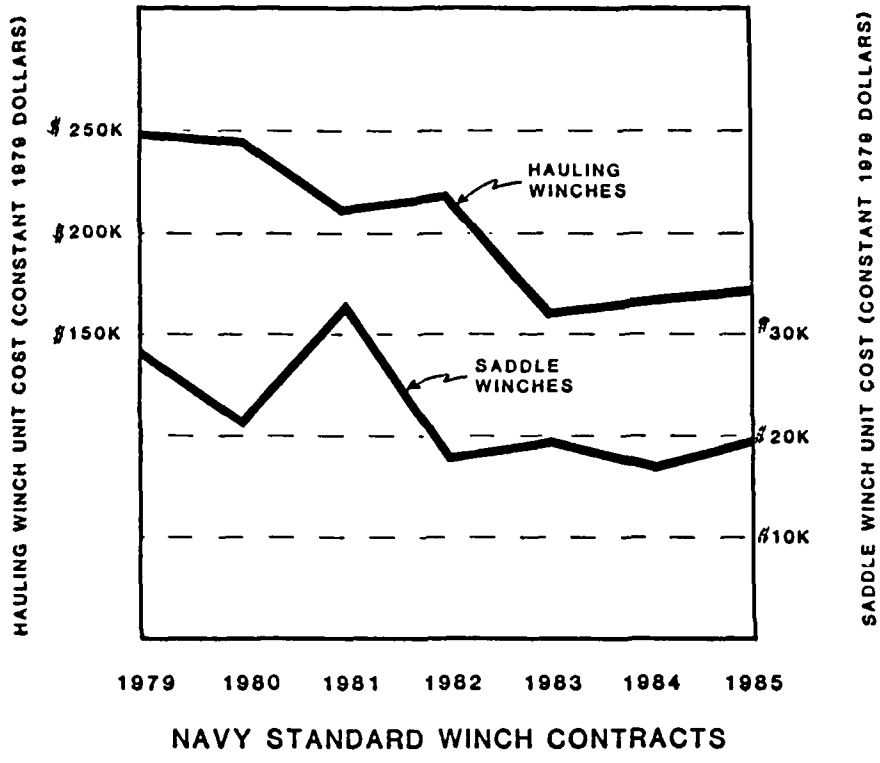

HAULING WINCH UNIT COST (CONSTANT 1978 DOLLARS)
$250K
$200K
$150K
HAULING WINCHES
SADDLE WINCHES
$30K
$20K
$10K
SADDLE WINCH UNIT COST (CONSTANT 1978 DOLLARS)
1979
1980
1981
1982
1983
1984
1985
NAVY STANDARD WINCH CONTRACTS

FIGURE 3

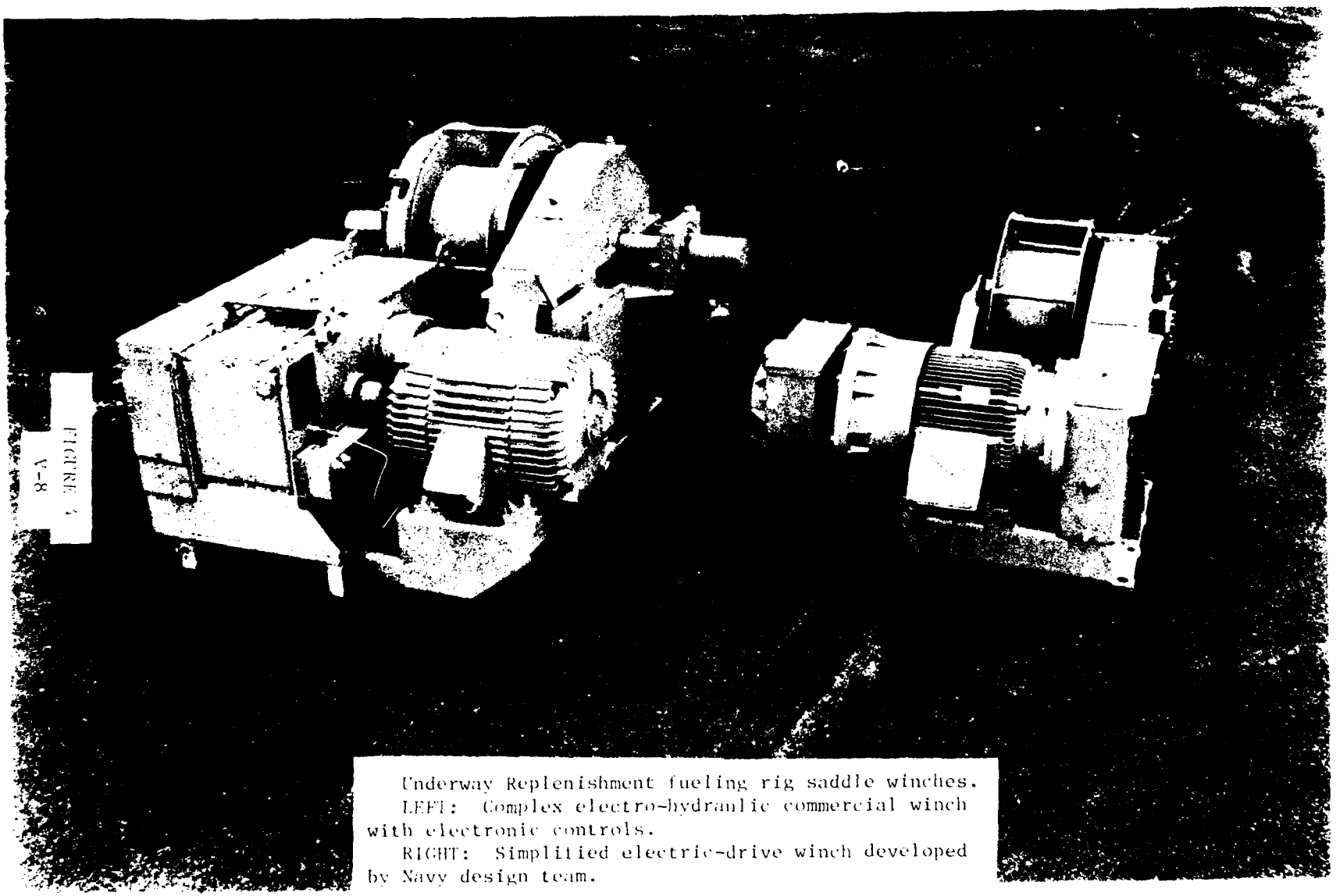


FIGURE 4
V-8

Underway Replenishment fueling rig saddle winches.
LEFT: Complex electro-hydraulic commercial winch with electronic controls.
RIGHT: Simplified electric-drive winch developed by Navy design team.

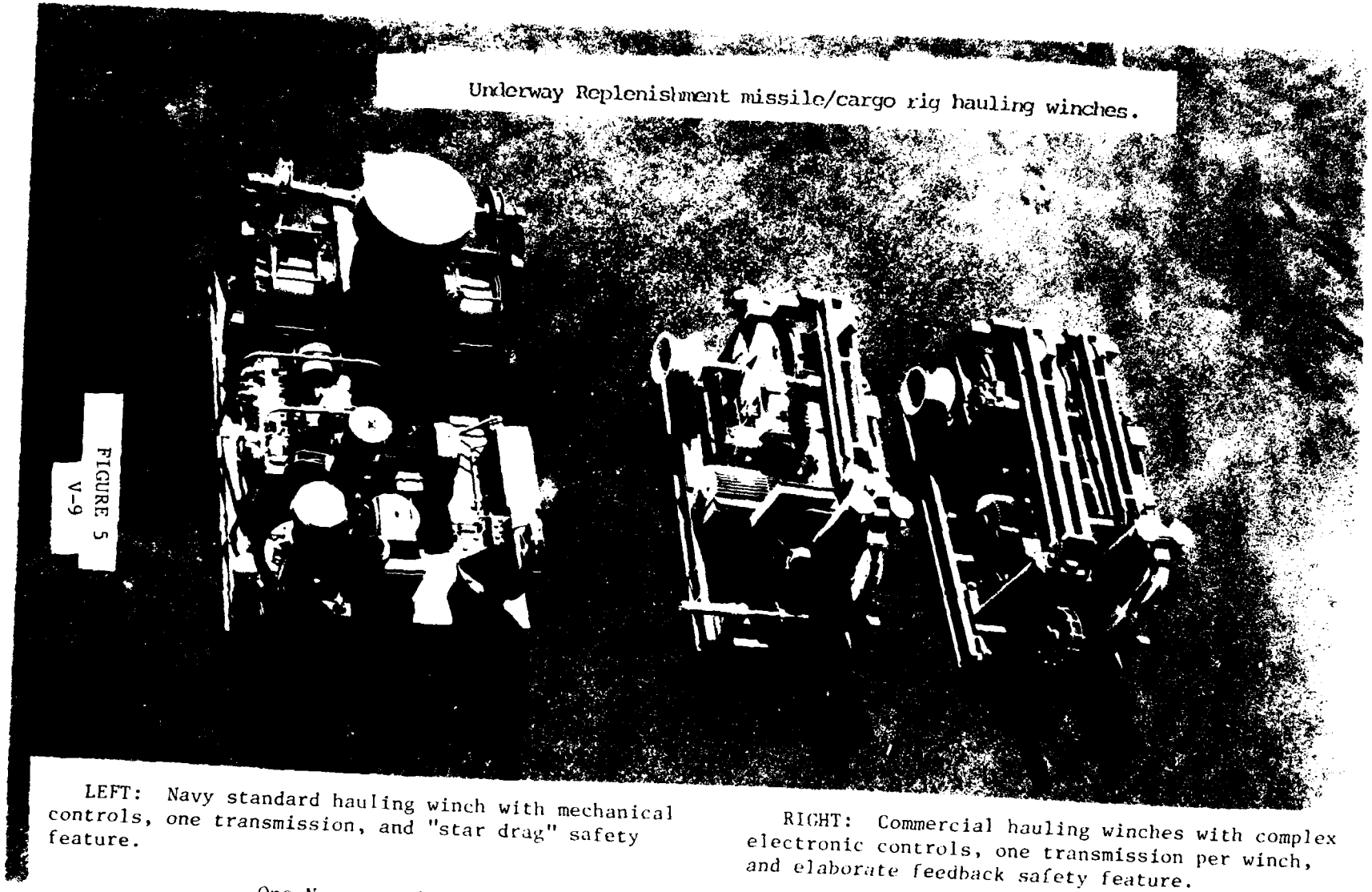


FIGURE 5
V-9

LEFT: Navy standard hauling winch with mechanical controls, one transmission, and "star drag" safety feature.

RIGHT: Commercial hauling winches with complex electronic controls, one transmission per winch, and elaborate feedback safety feature.

One Navy standard hauling winch replaces two commercial hauling winches.

SOLVING PROCUREMENT PROBLEMS THROUGH STANDARDIZATION

Purpose

This case study demonstrates the value of establishing requirements based on users' real needs rather than a vendor's claims, and the payoff that results from competition once these requirements are documented in a military specification.

Background

Very large quantities of multiple-wire electrical cable are used in civilian and military applications to transmit all types of data including audio and digital information for communications and control functions. In many civilian applications and nearly all military applications, it is necessary to shield these circuits from extraneous signals or interference. Cables can act as antennae receiving extraneous signals which can cause false alarms, incorrect commands, and intermittent errors. These cables can also radiate signals being carried and cause interference with adjacent equipment. Encasing cables in a metallic sheath or shield prevents unwanted signals from being radiated or received. Considerable work has been done by cable manufacturers to develop shields that are effective yet do not adversely affect flexibility and ruggedness.

A leading manufacturer of shielded cables is the Belden Company. Their product features their patented "Z Foil" construction which provides "100 percent cable coverage". Through effective marketing techniques, Belden made the engineering community aware of their claims. Eventually the majority of shielded cable procured by DOD was bought sole source by specifying Belden Part numbers.

Problems

The responsible DOD agency was tasked to establish technical criteria and prepare a procurement specification so that pending purchase orders could be broken-out to alternate sources. Completion of a procurement specification was continually delayed and this breakout never materialized. The accumulation of backorders was compounded by Belden's claim that additional production facilities would be required to fulfill DOD orders. Competitors complained to DOD and Congress that their products were comparable. Procurement agencies and engineering support activities were reluctant to apply "or equal" criteria because the specified 100 percent cable coverage was interpreted to mean 100 percent shield-effectiveness or zero emissions. No test to measure shield-effectiveness with accuracy and repeatability was known. Much time and effort were being expended within DOD to develop such a test.

The Defense Industrial Supply Center (DISC) is the central procurement agent for DOD purchase of wire and cable. The intransigence of the responsible DOD agency seriously jeopardized DISC's commitment to supply materiel on time and within budget. In July 1982, the Directorate of Engineering and Standardization (DISC-E) was called on to help alleviate the problems. The first questions DISC-E asked were: Is 100 percent cable coverage really required? If users could not get 100 percent coverage, what would they settle for? If coverage or leakage requirements can be properly defined, can an appropriate test method or analytic procedure be developed to demonstrate compliance? DISC-E determined that it

should be feasible to prepare a procurement specification if definitive technical requirements could be established.

Discussion Topics

1. List the major segments of the "user community" for shielded cable.

2. List in descending order of preference five different approaches for specifying test methods in a procurement document.

3. Who is authorized to prepare specifications and standards? Which organization provides authorization?

Outcome

Rather than develop a test to demonstrate 100 percent shield-effectiveness DISC-E set out to determine what users actually need. A series of meetings was arranged with major users. On the premise that the most stringent requirements were those of the National Security Agency, several meetings were held to review their most critical applications of shielded cable. Test reports comparing cable made by Belden and its competitors were reviewed during these meetings. It was established that 100 percent shield effectiveness is unnecessary gold plating and the procedures used in the comparison tests were sufficient to establish compliance with performance requirements.

Having established this position, other major users were contacted including the Air Force Engineering Installations Center and the Naval Electronic Systems Command. The Air Force conducted a worldwide survey of its users. The net result of these technical discussions with the user community was concurrence that:

(1) zero emissions was not an essential operational requirement, and

(2) analysis of existing test data was sufficient to determine whether acceptable levels of shielding had been achieved.

This effort was accomplished by DISC-E in less than 6 months and the results transmitted to the responsible DOD agency to expedite preparation of a procurement specification.

Ten months later it became apparent that real progress was not being made on the specification and a very serious backorder problem had developed for fifteen different cable configurations. In March 1984 DISC-E established a joint project with its sister organization, the Defense Electronics Supply Center (DESC). Starting with just the part numbers, DESC engineers gathered the massive amount of information necessary to accurately define each cable configuration as well as the basic specification detailing all the performance and quality characteristics that would enable competitive procurement. Within thirty days, this reverse engineering effort resulted in a draft that was circulated to more than fifty suppliers and users in Government and industry. Comments were received and resolved in the next thirty days and in May 1984 a DESC technical data package was released consisting of a procurement specification and 15 associated standard drawings.

Payoffs

During the 12 month period since May 1984 purchases by DISC to these standard drawings have totaled $1,730,650. If these purchases had been made at the prices prevailing just prior to release of the standard drawings, total costs would have been $3,459,800. Cost savings exceeding $1,729,000 (48 percent) have resulted form this standardization action during just the first year.

Direct costs to develop and implement the procurement specification and standard drawings include:

(a)	Initial DISC-E Study	200 man-hours
(b)	Estimated direct cost to draft and type the procurement specification, prepare the standard drawings, distribute to users, and resolve their comments	250 man-hours
(c)	Estimated time by industry and Government personnel in reviewing and commenting on draft	100 man-hours
(d)	Travel	$1,000

Total cost to the Government did not exceed $20,000 resulting in a net saving at DISC alone during the first year of at least $1,7000,000 and a return on investment of 89:1. Other government purchasing functions that use the specification and standard drawings are realizing similar savings. Invitations for bid are currently attracting an average of six bidders. It is noteworthy that in this newly competitive environment Belden often winds-up as the successful low bidder at prices that are significantly lower than their quotation for the same cable less than a year before.

Current Status

DISC is currently using these standard drawings to meet all its overall-shielded special purpose cable requirements.

In April 1985 DOD expanded its program to establish additional sources of supply through reverse engineering by directing the Services to utilized contract support services for this purpose in addition to in-house personnel.

Problems in Effecting a Solution

More than one hundred different DOD organizations are assigned responsibility for managing the standardization functions among the 600 Federal Supply Classes. The decentralized Defense Standardization and Specification Program depends on each activity to apply the necessary resources to handle priority problems. For various reasons specialist in cable technology were no longer available at the responsible activity to expedite standardization action on shielded cables. While this situation may not have adversely affected procurement actions at that base, it certainly affected other organizations which were counting on the long-promised specification.

This case demonstrates that while the Defense Standardization and Specification Program is a decentralized operation, it does have a command structure and procedures to provide for expedited action. Existing procedures enabled DISC and DESC to expedite circulation and review of the draft specification to industry and government so that a complete specification was available for use in competitive procurement less than ninety days after project authorization.

Topics for Further Discussion

1. What are the alternatives to specifying patented or proprietary designs?

2. List at least five reasons why standardization projects might be delayed. Specify appropriate corrective action for each.

3. Private sector international standards average seven years from authorization to publication; nongovernment voluntary standards typically take four to five years. Are there reasons why DOD specifications or standards could be developed in a shorter - or longer - time frame than in the private sector?

NAVY REAPS SIGNIFICANT COST SAVINGS AND OTHER BENEFITS WITH SHIPBOARD COPIER STANDARDIZATION

Purpose

Widely used, authorized procurement techniques can compound maintenance problems in some situations and significantly increase life cycle costs. Standardization can be the innovative solution that increases equipment availability and uptime while realizing very large cost savings and cost avoidance.

Background

As in any modern business enterprise, a Navy ship must make multiple copies of all types of documents, records, and communications so that policy, direction, and requirements can be effectively communicated not only within the ship but to its home base, port authorities, the logistics system, and the many different elements that enable a ship to accomplish its mission. The Battleship New Jersey, for example, has eight copiers on board, four of which are the kind that might be found in a typical small office; two that are of medium volume - 20,000 to 40,000 copies per month - and two larger units for high volume copying. A carrier like the Nimitz, Figure 1, has 47 copiers to support ship operations as well as its aircraft. Thirty-one of these are low volume copiers. Destroyers typically have 6 copiers on board, while an amphibious support ship (LPD Class) has 4 copiers. Altogether, 616 combat ships of the Navy and transports of the Military Sealift Command have a total of 3557 copiers.

These copiers are required to operate in the unique shipboard environment. A copier cannot just be placed on a table or on the deck as in an office. It must be fastened in place so it does not move about and become a hazard to equipment and

personnel as a ship maneuvers in a rough sea. Copiers are subjected to vibration and shock from the ship's machinery, ordnance, and other sources. Average life for a copier in this environment is two to three years.

Then there are the often overlooked effects of electromagnetic interference (EMI). These effects are experienced even in benign office environments ashore. Erasures of data in word processing systems have been caused by copiers operating in the vicinity. Generation of spurious signals and electrical noise can create havoc on ships which are crammed with sensitive electronic communications and control equipment. Figures 2 and 3 exemplify two different copier installations on board the Nimitz.

Most businesses that use copiers have service contracts that provide periodic maintenance and quick attention by trained technicians whenever there is a problem. When a ship is at sea the factory trained technician may be thousands of miles away.

Problems

Reports were being received from the Fleet of a variety of problems with copiers. A study by the Navy Publications and Printing Service determined that the Fleet's copiers are supplied by 27 different manufacturers with an average of two models per vendor.

The following types of problems were being experienced:

- Inability of some models to operate reliably in the shipboard environment;
- Inadequate maintenance while at sea;
- Difficulty in obtaining spare parts and vendor service in many overseas locations;

- Need for a wide range of maintenance expertise to handle the variety of makes and models of copiers; and
- Need to carry a large and varied inventory of consumables - toner, developer, fuser oil, drums - for the various copiers.

The proliferation of models stemmed from an automated Navy selection system intended to provide guidance in selecting appropriate models from the hundred or so models on the GSA Schedule. As the central purchasing agency for the Federal Government, General Services Administration establishes, through competitive procurement practices, the most advantageous price for equipment and supplies used by many agencies. The suppliers and their prices are listed in the GSA "Schedules." The built-in flexibility of the Navy's selection system combined with equipment already onboard resulted in a great variety of equipment.

Discussion Topics

1. What options does DOD have to assure procurement of equipment that can operate in the unique environments of DOD applications?
2. Can DOD ever hope to buy commercial equipment at a reasonable price that can operate in a rugged environment? Why?
3. How is commercial equipment used by DOD serviced and maintained at remote locations?
4. Since standardization limits variety, aren't the terms *"standardization"* and *"competitive procurement"* mutually contradictory? Why?

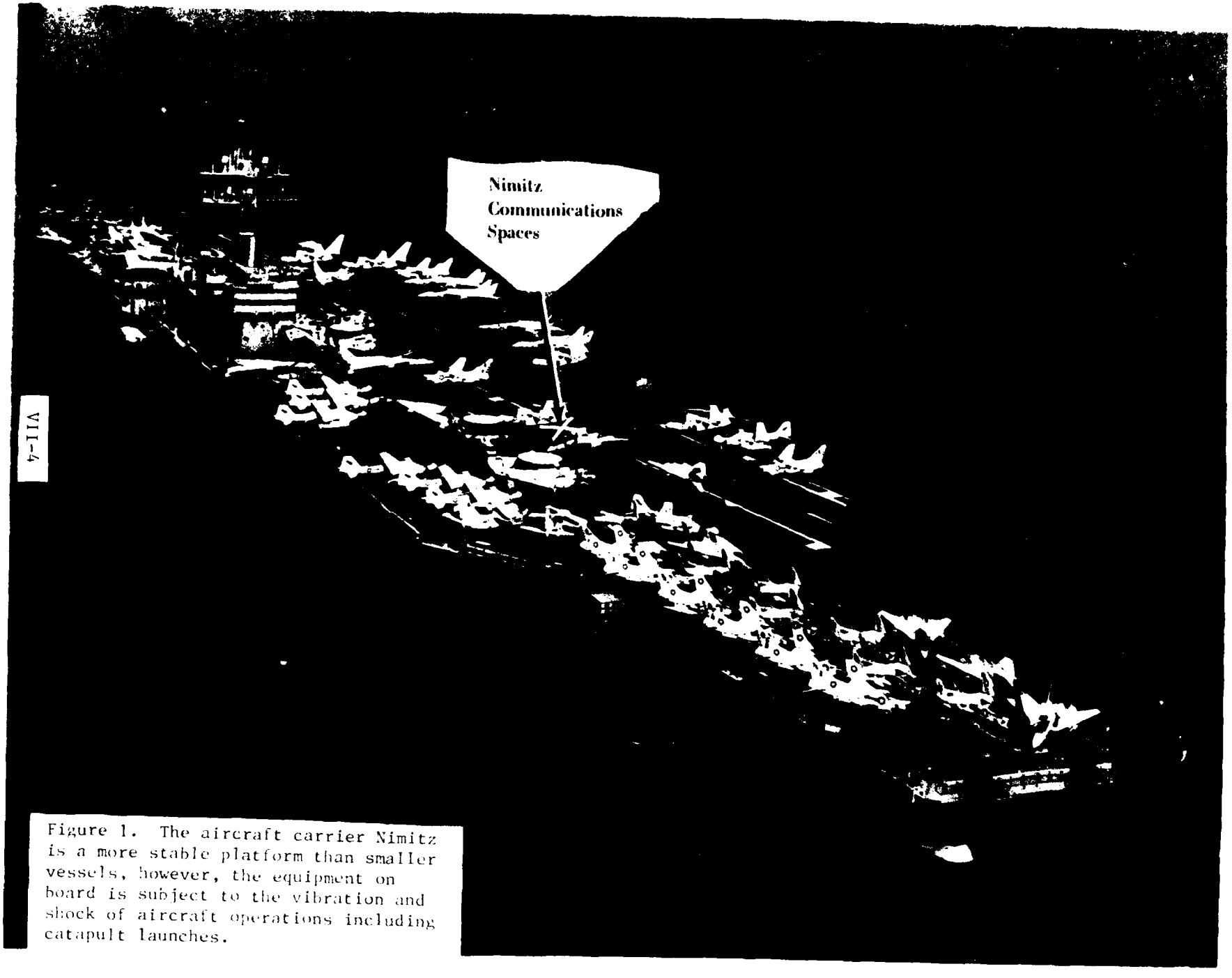


Figure 1. The aircraft carrier Nimitz is a more stable platform than smaller vessels, however, the equipment on board is subject to the vibration and shock of aircraft operations including catapult launches.

Figure 2. A communications center on the Nimitz with a medium volume copier in the foreground.

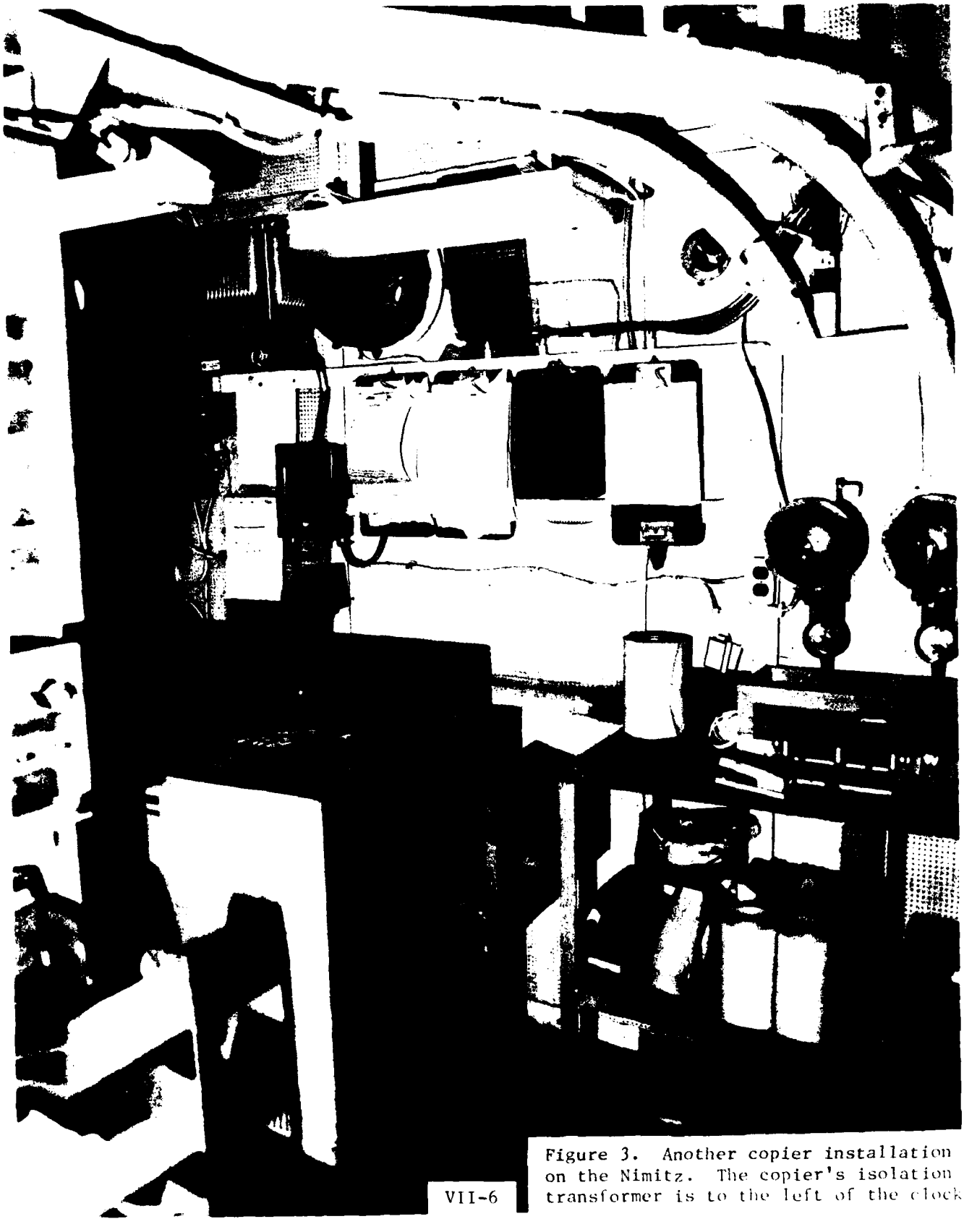


Figure 3. Another copier installation on the Nimitz. The copier's isolation transformer is to the left of the clock.

Outcome

With the cooperation of responsible Navy commands, the Navy Publications and Printing Service analyzed the Fleet's copier problems and developed a number of recommendations. In addition to the inherent problems of operating in the shipboard environment, this study determined that only two of the 27 vendors supplying copiers were providing formal maintenance training. Overseas parts support and vendor emergency maintenance service were provided by only one of the vendors. At times vendor technical representatives were flown thousands of miles in military aircraft to repair copiers. Certain copiers used low flash-point, volatile liquid toner which created a hazardous condition from fume contamination and further complicated the storage of consumables for these copiers.

Equipment used on board submarines must be able to pass through a 22 1/2 inch hatch. There was no assurance that a copier ordered from the GSA schedule could be put on board a submarine. There was no logistics support plan and ships were burdened with considerable administrative work to order and pay for copiers and consumables.

It was clear that reduction in equipment, consumables and spares could not be achieved through continued use of GSA Schedules. Standardization was recommended as the preferred solution to solve most of the problems. The Chief of Naval Operations authorized implementation of the Standard Shipboard Reprographic Equipment (SSRE) program in September 1983. A joint Navy - GSA task force was formed of technical, management, and contracting specialists. All affected elements of the Fleet and the Military Sealift Command participated. Through individual and collective efforts the numerous technical and contractual requirements were established.

1. It was agreed, as a basic premise, to use commercially available copiers, if at all possible, rather than a fully militarized, costly, and probably unique, copier.

Government technical specialists believed that relatively minor modifications could upgrade commercial copiers so they could function reliably in the shipboard environment.

2. An analysis of copier applications in the Fleet helped define four standard classes of copiers based on monthly reproduction rates:

Class I, Low Volume ..... up to 20,000 copies

Class II, Medium Volume ..... 20,001 to 40,000 copies

Class III, High Volume ..... 40,001 to 100,000 copies

Class IV, Ultra-High Volume ..... 100,001 to 500,000 copies

This analysis also established the quantities of copiers required for new installations or replacements during the period 1986 through 1990.

Class I 3720

Class II 2285

Class III 852

Class IV 84

3. A technical team determined that the critical aspects of the shipboard environments were electromagnetic interference, shock, vibration, inclination, temperature and humidity, and electrical power surges and variations. Rather than invoke a wide ranging military specification, the performance requirements of each of the critical aspects were selected from appropriate Federal Military and nongovernment standards including those of Underwriters Laboratory and the Institute of Electrical and Electronic Engineers. All requirements were tailored to reflect the specific levels of performance required to operate copiers satisfactorily in the various shipboard environments. Product specifications for the copiers were developed with the help of GSA in-house technical experts. All current copier test publications/reports, feature matrixes, buying guides, etc. were reviewed to

develop copier specifications that would meet the Navy's needs, but would also promote maximum competition and low prices. In addition, visits were made to Navy port facilities to interview shipboard copier users to get their input on copier requirements.

4. A technical survey was sent to prospective bidders to obtain information on the feasibility of commercial copiers complying with unique Navy requirements, with low cost modifications. Survey results indicated that a sufficient number of copier manufacturers (in terms of competition) would be able to meet the special technical requirements at a minimal cost for any special modifications. In addition to the survey, members of the task group visited contractor's plants to discuss proposed equipment, equipment modifications, cost of modifications, delivery schedules, etc.

5. A task team focused on maintenance and training needs. Allowed Equipment Lists were established for each ship and a logistics support plan was developed. Homeport locations were reviewed to determine the best locations for training and to identify where vendor technical representatives would be needed.

6. All of the technical requirements, support, and training plans were incorporated into product specifications and the request for proposal for the four standard classes of copiers. This solicitation was circulated in March, 1985.

7. Using life cycle cost techniques GSA, determined that the best approach to maximize competition was to request bids on each class of copier. They determined that the appropriate procurement instruments would be multi-year, fixed price, indefinite quantity contracts for copiers, consumables, training, and support. This strategy would provide the necessary control and standardization essential for effective equipment maintenance by reducing the diversity of equipment from 27 vendors to a maximum of four. Contracts

would be for one year, with options to extend up to four additional years. The decision to go with a five year project life span was based on the complexity and scope of the standardization program. Total implementation of copying equipment in the Fleet will probably take 36 months to accomplish.

This contracting method will allow the Government to seek other vendors if current vendors prove unsatisfactory. This, however, is not likely to happen. Once a vendor is awarded a contract, and establishes training sites, sets up technical representatives at two dozen locations in the U.S. and a dozen overseas, as well as the rest of the logistic support program, it is unlikely that his contract would not be renewed at the end of the contract year, unless his prices were grossly out of line with prices for the same goods and services, compared to the commercial marketplace, at the time the contract came up for renewal.

8. To assure that vendors properly addressed EMI and other performance and environmental requirements, the RFP required testing during the pre- and post-award phases of the contract. Prospective vendors were required to submit with their proposals data on the EMI "*hardness*" of their copiers. Testing was performed at their expense by qualified commercial testing laboratories. After approval of their technical proposals, vendors demonstrated that their equipment met all the operational requirements. After award of contract each class of copier was subjected to all environmental tests. These tests were performed at a Navy laboratory at Government expense. Vendors provided one unit of each class for these tests.

The solicitation of bids yielded responsive, competitive proposals. Technical review of EMI test reports precluded consideration of copiers made by a major manufacturer. After thorough analysis of the bids based on life cycle costs, two contractors were chosen - Savin for the Class I copiers, and Xerox for the other three. First article testing at the Navy laboratory was completed in December 1985 and

demonstrated that commercial copiers could perform satisfactorily in the shipboard environment with modest, but effective, modifications. The costs of modifications, mounting kits and other special requirements for shipboard applications averaged seven percent of the overall cost which was considerably lower than acquisition costs if purchased from the GSA schedule.

Payoffs

This joint GSA/Navy effort results in considerable cost savings and cost avoidance. Prospective bidders recognized that the large quantities that would be procured under this multi-year contract were a unique opportunity. Their bids reflected not only the economies of scale resulting from significant quantities, but the efficiencies resulting from centralized purchasing and program management.

Major savings are realized in copier maintenance. Contractor-trained Navy technicians will be aboard each ship, equipped with all tools and parts required to perform all but the most major repairs on equipments. These Navy technicians, able to perform repairs whether in port or under way, will eliminate the need for present Full Service Maintenance Agreements, and associated costs. Maintenance costs will be reduced to one-sixth of current costs. Other benefits include bulk ordering of consumable supplies and materials, which will result in a savings of 50 percent over current practices of custom ordering small quantities by individual ships.

This program will greatly relieve the Fleet's existing administrative burdens by simplifying the copier approval cycle, significantly reducing service calls, reducing supply and inventory procedures, and streamlining reporting requirements.

Total savings and cost avoidance through 1990 will be in excess of $58 million. A breakdown of some of the major areas benefiting from this standardization program are itemized here.

EQUIPMENT

Items on GSA Schedules are at the lowest commercial prices. No other commercial customer receives lower prices. If the equipment, maintenance, spares, and consumables had continued to be purchased using GSA multiple award schedules total costs would be $124 million. Costs for these same items after standardization, including modifications for the shipboard environment, are $72 million.

	Costs of Commercial Copiers from GSA Schedule	Costs for Standard Copiers
Class I	$36,854,784	$18,028,058
Class II	35,004,096	22,142,043
Class III	36,545,580	25,214,969
Class IV	15,732,000	6,819,099
	$124,136,460	$72,204,169

These life cycle costing projections apply present value discounts to acquisition from GSA Schedules and contracts negotiated by GSA for the standardized copiers.

ISOLATION TRANSFORMERS

When copiers have been purchased for shipboard installations isolation transformers would also be ordered to prevent damage to the equipment from voltage spikes and surges. (See Figure 3.) The standard copiers are state-of-the-art with built-in surge protection and do not require isolation transformers. Cost avoidance totaling $1,735,000 results from not buying 3389 transformers. When existing copiers with isolation transformers are replaced by standard copiers the transformers can be used in other applications on board ship resulting in additional cost avoidance.

DUPLEXING

The Class II medium volume standard copiers will be able to copy on both sides of a sheet of paper with one pass through the machine. Existing equipment does not have this automatic duplexing feature. Based on the phased introduction and replacement of Class II copiers, and the expectation of duplexing half of the copies that are made, and the cost of paper at $.0065 per sheet, savings of $4,284,540 are expected through 1990. Automatic duplexing is also a feature of Class III and IV equipment.

ADMINISTRATIVE

While not directly attributable to standardization, $69,000 per year will be saved in administrative costs through centralization and simplification of equipment acquisition and payment. This saving would not have been significant and improvements in the procedures would not have been practical until equipment varieties had been standardized to four models from two vendors.

Summary of Savings Over 5 Years

Equipment	$51,932,291
Isolation Transformers	1,735,000
Duplexing	4,284,540
Administrative	345,192
	$58,297,023

COSTS

Standardization cannot be accomplished without an investment of qualified manpower and other resources. The standardization task force consisted of twelve specialists from GSA and the Navy primarily in grades GS 13 and 14. The task force

met 36 times during this project. These meetings plus assignments stemming from these meetings totaled 4000 manhours. During this period two GSA specialists worked on this project full time, and a technician participated for nine months for a total of 10,000 manhours. Altogether approximately seven manyears, or $350,000 in salary and overhead, were invested in the project by the Navy and GSA. In addition, approximately $50,000 was spent for first article testing at the Navy laboratory.

It is debatable whether the additional expense for modifications to meet shipboard operating conditions should be charged to the standardization effort. Reliable operation is, after all, a basic expectation. It is useful, however, to examine the additional costs for modified commercial copiers to meet the product specifications that assure reliable operation on board ship.

	Internal Equipment Modifications	Mounting Kits	Total	Cost per Copier
Class I	$2,385,000	$1,048,000	$3,433,000	$923
Class II	1,200,000	175,000	1,375,000	$602
Class III	213,000	136,000	349,000	$410
Class IV	87,000	36,000	123,000	$1464
			$5,180,000	

Summary of Investment Costs

Manpower	$350,000
First Article Testing	50,000
Travel	20,000
Modifications	5,180,000
	$5,600,000

ROI

The return on investment from this standardization project is conservatively 10:1.

Current Status

The Navy and GSA performed as a team throughout the process of preparing product specifications, distributing the solicitation, receiving and evaluating bids, and subsequently making contract awards. Both organizations gained much new information and insight into copiers and users' needs. Lessons learned from this unique standardization program and other GSA standardization projects are now being applied to the acquisition of copiers at the Navy's shore facilities. Eventually the other Services and other Government agencies should benefit from the pioneering standardization efforts of the Navy and GSA.

Problems In Effecting A Solution

Vendors would have bid even lower costs if procurement had been based on definite quantities delivered in accordance with specific schedules. This was not possible because funding is on an order-by-order basis and comes from the budget of each ship. Multi-year funding has not been designated for the Navy's copier needs. It is expected that as the benefits of this standardization program are realized the Navy will begin planning to obtain funds for a multi-year, definite quantity program.

Topics For Further Discussion

1. How are environmental levels established for equipment installed in aircraft, ships and vehicles? Where can authoritative guidance be obtained for selecting the appropriate combination of environmental conditions and severity levels?
2. List the major steps and a timeline to develop and acquire a uniquely military medium volume copier that could be used aboard ships, airborne command posts, and mobile landbased tactical command posts in a wide variety of C3I

applications. Estimate Government and contractor development costs and life cycle acquisition and operational costs for approximately 2300 copiers.

PRIMARY INDICATORS OF STANDARDIZATION ACCOMPLISHMENT AND COST

The ideal measure of standardization accomplishment is to convert all benefits to dollars and cents. Unfortunately of the fifty or more benefits that are customarily attributed to standardization action, at least half are intangibles such as "providing a common language between buyers and sellers" or "improving quality control based on accepted and explicit specifications". Intangible benefits usually cannot be stated in terms of money, manhours, or other resources. Considerable time can be spent conceiving elaborate formulas with constants and factors to accommodate various situations, but the results will be of questionable value. For these reasons assessors should concentrate on tangible benefits.

Money saved through standardization is usually "negative money". It represents money not spent; materials not handled; space not required; labor not expended; and time not used.

One approach to measuring standardization accomplishments is through effectiveness indexes. While these are not the complete answer, information may be readily available. A common measure of standardization effectiveness for equipment is to determine the portion that is documented by standards. A variant is to determine that portion of the total costs for parts and materials and that portion that are standard parts and materials:

$$\frac{\$ \text{ Standard Parts and Materials}}{\$ \text{ Standard and Nonstandard Parts and Materials}}$$

Effectiveness indexes are particularly appropriate when a baseline effectiveness ratio has been established for a particular class of equipment, e.g., aircraft 60 percent standards, missiles 70 percent, ship's hull and mechanical equipment 40 percent. These can then form a basis for comparison.

Variety Reduction

Standardization action that reduces variety or limits further proliferation of different types, sizes or kinds of equipment, components, parts, or material is particularly appropriate for quantitative measurement. Probably 80 to 90 percent of the standardization projects in Government and the private sector are in these categories of variety reduction. Benefits from variety reduction accumulate in two ways: one due to variety reduction itself, and another by restricting further variety growth. The positive benefits of restricting variety growth are realized at very little cost as soon as people are made aware that the standard exists. Together, these two benefits of variety reduction constitute Gross Standardization Revenue which consists of:

(1) the revenue accruing from tangible benefits, and
(2) additional, cumulative revenue from limiting variety growth.

Calculating Gross Standardization Revenue

Tangible benefits show up in four primary areas:

(1) Avoiding costs of specifying new items;
(2) Realizing larger discounts for larger purchases, or better prices because additional competitive sources are now available;
(3) Reducing the number of purchase orders and receiving inspections because of increased order quantities or annual agreements for standard products;
(4) Reducing inventory and inventory carrying costs.

These four primary areas plus the revenue from limiting variety growth are the most readily identifiable and retrievable quantitative elements of standardization accomplishment.

Except for actual discounts derived from larger quantity purchases and price reductions from competition, these cost factors need to be determined just once, and then revised periodically. Purchasing and Receiving Inspection should be able to provide the cost of processing a purchase order or inspecting a lot. Inventory carrying cost is a widely used measure of the cost of operating a warehouse. An audit of engineering operations will establish the cost of specifying a new item. This is best determined by determining the number of manhours to specify an item which is defined by a standard versus an item which does not have a standard. Factors to be determined are expenditures for:

- Engineering search
- Engineering design
- Drafting, checking, releasing, and if applicable, testing
- Paperwork for stock control
- Paperwork for inspection plans.

Typically the difference is from 15 to 25 manhours for common hardware and components.

In many instances variety reduction is accomplished only after the number of varieties and the inventory have reached unreasonable size. In these cases expenditures for engineering, release, stock control, etc. cannot be recouped. These are often called "Sunk Costs" because once they are spent they can never be retrieved. This is a strong argument for variety control at the earliest stages possible in design, production, or maintenance.

Determining the rate of variety growth is fairly straightforward within DOD. Data is available on the number of different new FSN's added in any year. Most Standardization Program Plans contain sufficient information to establish the growth rate or, if need be, Program Plans from prior years can yield appropriate data points.

Calculating Standardization Costs

Any report on the savings or cost avoidance accomplished through standardization must include information on what it costs to achieve these economies, otherwise some might think standardization comes free, or at little expense.

As with most enterprises standardization costs are classified as Fixed and Variable.

Fixed Costs consist of:

- Maintenance of a standards library and reference books;
- Participation in standardization meetings and seminars;
- Training for the standards staff;
- Training of personnel at the base or command;
- Providing general advisory services;
- Supervision.

In private industry these constitute the overhead costs of a Standards Department.

Variable Costs are directly related to the number or size of standardization projects. These are usually further classified as Investment Costs and Running Costs. Investment Costs include:

- Expenditures associated with the development of the standard or specification;

- Cost of coordinating a document including the time of those who review and comment on drafts;

- Announcements, seminars, consultations and similar efforts to make potential users aware of a new standard to encourage its use;

- Implementation Costs which include change orders to incorporate new standards in existing designs as well as changes to production and inspections procedures; equipment or subassembly tests to verify that new standard parts, materials or processes can replace existing items; the costs of changing stock numbers in repair parts lists and revising maintenance manuals; and the loss when stock is scrapped and replaced by a standard.

- Revision Costs whenever a standard is corrected or updated.

In addition to these Investment Costs there are Running Costs, the most common of which is time spent interpreting details of a particular standard or advising on applications.

In some cases the use of a standard item may incur certain penalties which are usually accepted because the overall benefits outweigh the penalties. These are the costs due to restricted choices. Circuits may be overrated because of the choice of preferred values for circuit breakers. Hydraulic hoses may have higher than necessary safety margins because standard hoses are rated at wide ranges of pressure. These penalties are termed Adaptation Costs and are included as Running Costs.

Running Costs are usually proportional to the Investment Costs of a standards project. A project that is expensive to develop and implement is usually expensive to maintain. There is usually a direct relationship between these costs and the "volatility" of a technology. Standards for microelectronic devices have higher investment and running costs than standards for steel cable. Significantly, the life-time of standards for these volatile technologies is considerably shorter than in other fields. The standardization activity, then, has less time to recoup its investment and start to show a reasonable Return on Investment (ROI).

Reporting Standardization Accomplishments

The most straightforward measure of a standardization project is its Net Standardization Revenue. This is the Gross Standardization Revenue from which total Investment and Running Costs are subtracted. After the first year these should be accumulated and reported as Cumulative Net Standardization Revenues. These can be reported for an individual standardization project, a group of projects, or an entire standardization program.

The second item to report is Return on Investment for the immediate past year as well as the cumulative ROI. The ROI for an entire standardization program is the total annual revenues for all standardization projects divided by the total standardization costs - both Fixed and Variable - that same year.

Finally, a standardization accomplishment report should list the major intangible benefits that are being realized.

In reporting results the following guidance should be carefully considered:

1) Cost and benefit factors must be conservative and supportable to earn credibility and acceptance.

2) To acquire valid data gain the cooperation of those organizations that ordinarily have this data.

3) Share credit for Standardization Revenues and other benefits with the organizations that implemented the standards.

4) Be reasonable; give credit for normal, expected performance and improvements in productivity.

5) Periodically update or validate cost factors.

6) Recognize the Pareto Principle - that 80 percent of the required data can be accumulated in 20 percent of the time - and be satisfied with 80 percent of the total data even though every single benefit or cost element may not have been incorporated.

Focusing on Results and Accomplishments

Development of these case studies once again demonstrated that, with few exceptions, DOD standardization activities concentrate on document preparation and maintain data on just this aspect of their operations. These generally show how resources were spent not what was actually achieved. It is essential that all DOD standardization personnel, particularly managers, recognize that evaluation and

systematic presentation of standardization benefits and the costs to achieve them are fundamental necessities to:

- ensure continued support of the program;
- allocate available resources to get the most effective results;
- identify the point of diminishing returns so that efforts can be redirected to more profitable projects.

This paper summarizes the basic cost factors that are applicable to more than 80 percent of DOD's standardization projects. Standardization project managers should be encouraged, or even directed, to apply the cost factors described here in their annual reports and program plans. This discipline will pay off in many ways in addition to providing the basis for effective, well documented case studies. Once these techniques are applied to variety reduction standardization projects, managers will be motivated to adapt or develop other approaches to measure the costs and benefits of other types of standardization action.

GUIDELINES FOR COMPLETING A STANDARDIZATION CASE STUDY ANALYSIS

The adoption of the case study method of analysis to real-world standardization policies and practices will have a positive influence, provided the case studies:

1. Clearly focus on an identifiable problem and provide an uncomplicated view of all issues.

2. Are based on data gathered from first-hand observations and interviews with practicing managers from user organizations.

3. Are logically structured so that the reader can easily grasp the purpose of the case, problems, outcome, and supporting rationale for the action taken.

4. Demonstrate an ordered approach to analyzing a standardization problem.

Data collection and organization are of major importance when writing standardization case studies. Case studies should be developed from factual material, written in plain English, and presented in an easily understood manner.

The first step in the development of standardization case studies is to identify the candidates. All available information resources should be utilized. Candidates can be found in newspaper articles, industry and DOD publications, and annual standardization accomplishment reports, but the best source of information for candidate case studies is personal contacts. A case writer should notify key personnel of the intent and purpose of the case studies and ask them to keep their eyes open for examples of good and bad standardization accomplishment with case study potential. A good candidate should be straightforward, not too technical in nature, and have proven payoffs. This means that the standardization action must have taken place far enough in the past that the effects of the standardization action (or inaction) are real and measurable.

Once the candidates have been found and documented in short summary form, the candidates are screened, and the best examples are chosen for complete development. A great deal of research, telephone and personal interviews must take place to properly screen the candidates. When interviewing, a case writer should "keep the blinders on" and ask only well-prepared questions that keep the purpose of the case in focus. The case study format can be used for guidance in questioning key personnel. The format, which should be the same for all case studies, shows how the case will be broken down and gives an explanation of the section headings. It keeps the case writer "on-track" and limits data collection to significant information. An example of a good format is attached.

When writing the case study, a "plain English" style is recommended. This style of writing is the best way to keep the reader's attention and it is the clearest form of writing. Avoid overly technical discussions, jargon, and acronyms. Keep the case study as short and concise as possible. Ideally, they should not exceed six single spaced pages of text. Pictures and exhibits are useful to maintain reader interest if they are pertinent.

Following are some points to be considered when writing a case study:

- A case writer takes the role of an investigative reporter when gathering data for input. During telephone and personal interviews it is important to be tactful so that quality data can be acquired.

- The "inside" story reported to the case writer may be, in fact, a public relations statement; that is, what the organization wants known and nothing else. It is recommended that the case writer research the case study in detail before the interview and seek information from other offices that may have been involved in the action.

- Cost data may be difficult to obtain. Historical data relevant to the cost of the standardization program is essential for a complete analysis. The case writer may have to be persistent in his search for relevant data.

- In developing Discussion Topics recognize that the reader will have had some initial instructions or readings in the principles and practices of standardization. Discussion Topics can help focus information already learned onto real problems.

CASE STUDY FORMAT

PURPOSE:

Statement as to why this case study is being conducted and an opinion concerning the relative importance of this problem to the field of standardization, and the expected benefits of the study's results.

BACKGROUND:

Factual material about the agency or contractor which will logically prepare the reader for the problem(s) being processed.

PROBLEM:

How the situation requiring standardization action developed. Definition of the standardization problem(s) faced by managers in the actual situation(s), including relevant significant data.

DISCUSSION TOPICS:

Case related questions or areas or interest which help the reader to focus on key issues and decision points, or promote individual study or group discussion.

OUTCOME:

A complete summary of the course(s) of action implemented to resolve the stated problem.

PAYOFFS:

Present net costs of the standardization action, accrued and/or projected benefits.

CURRENT STATUS:

A short summary of status and planned future actions, if any.

PROBLEMS IN EFFECTING A SOLUTION:

Report on unexpected problems encountered during the standardization action; e.g., personal attitudes, DSSP procedures, etc.

TOPICS FOR FURTHER DISCUSSION:

Issues or principles that warrant consideration with the guidance of the instructor. Newly promulgated regulations or exceptions to existing practices are particularly appropriate.

EXHIBITS:

Significant pages from prepared documents; worksheets estimating costs and benefits; photos and diagrams.

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